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(RESEARCH ARTICLE)

Growth performance, serum metabolites, plasma protein fraction, meat lipid profile and antioxidant activities of breast meat of broiler chicken fed diets containing *Cinnamomum ceylon* powder, *Zingiber officinale* powder and *Moringa oleifera* leafmeal supplementation

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Abstract

An experiment was conducted to determine growth performance, serum metabolites, plasma protein fraction, meat lipid profile and antioxidant activities of meat of broilers as affected by *Cinnamomium ceylon*, *Zingiber officinale* and *Moringa oleifera* supplementation. A total of 112 day old chicks were allotted into four treatments replicated four times with seven birds per replicate in a completely randomized design (CRD). Basal diets were formulated for broiler starters (0-28days) and finisher phase (29-56) days. The basal diets were divided into 4 diets : diet 1- control diet without supplementation; diet 2- contained 0.2% *Cinnamomum ceylon* supplementation (CCS); diet 3- contained 0.2% *Zingiber officinale* supplementation (ZOS), diet 4-contained 0.2% *Moringa oleifera* leafmeal (MOLM) supplementation. The experiment lasted for 56 days. Results showed an improvement in final liveweight, weight gain, feed intake and feed conversion ratio of birds on 0.2% MOLM. Birds on phytogenic feed additives have lower values of urea, cholesterol, glucose, high density lipoprotein and low density lipoprotein. Birds administered phytogenic supplements exhibited much greater plasma albumin levels. Low levels of meat cholesterol, triglycerides and low density lipoprotein were found in birds fed phytogenic feed additives while high levels of high density lipoprotein were recorded for birds on phytogenic feed additives. The supplementation of broilers diets with phytogenic feed additives increased the glutathione peroxidase and superoxide dismutase and decreased lipid peroxidation. It was concluded that supplementation of broiler diets with *Moringa oleifera* leaf meal enhanced body weight gain, antioxidant activities also reduced cholesterol level in both serum metabolites and meat.

Keywords: Phytogenic; Broilers; *Zingiber officinale;* Lipid profile; Plasma protein fraction.

1. Introduction

Due to the quick development, broiler chickens are typically grown for meat. Furthermore, broiler chicken meat is a good source of protein, which makes it popular among customers. Broiler meat is also a better choice for customers because of its lower lipid content. However, broiler meat has become a substantial component of human diets. As a result, there was a rise in worldwide demand for meat (Arshad *et al.*, 2016; Santhi *et al.*, 2020). Consumers prefer meat with minimal or no cholesterol. Furthermore, consumer preferences have shifted from the entire bird to its processed portions, increasing the significance of meat production and quality traits even more. In an attempt to win over customers, meat quality is being improved and its storage capacity is being increased. Chicken breast meat is important for diets because it has a larger amount of polyunsaturated fatty acids than meat from other species (Berzaghi *et al.*, 2005; Riovanto *et al.*, 2012).

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Antibiotics have been used in broiler feed for years in order to treat and avoid diseases, improve performance, and boost feed efficacy (Roth *et al.*,2019). Antibiotics are more likely to accumulate in residual form when used non-therapeutically than when administered medically, raising the risk of antimicrobial resistance. In addition, the European Union prohibited the use of antibiotics in animal feeds in 2006 due to toxicity concerns and the growth of microbial resistance. To prevent the development of antibiotic resistance, broiler chicken meat must be produced without the use of antibiotics (Haque *et al.*, 2020). Research containing the majority of the plant's active substances have been reported in a significant number of scientific studies to promote health and enhance zoo technical performance by increasing nutrient availability for animals due to their antioxidant and anti-inflammatory effects, gut microbiota modulation, beneficial impacts on gut quality resulting in better performance (Diaz-Sanchez *et al.*, 2015; Upadhaya and Kim 2017) and improved nutrient diversion. Additionally, consumers are concerned about antibiotic residue in addition to nutritional value and flavor. Finding suitable alternatives for growth promotion and feeding effectiveness was thus also necessary.

In recent years, the feed industry has begun to recognize the benefits of plant-derived chemicals for numerous animal species. As a result, the usage of phytogenic feed additives is increasing, notably in pig and poultry diets. Phytogenic elements in PFAs include herbs, spices, essential oils, and non-volatile extracts from plants such as clove, anise, thyme, fennel, or melissa, among others (Ma'the 2007). Numerous phytogenic actions that promote development and health have been discovered in a growing number of research publications. According to Amad *et al.* (2011), phytogenics improve chicken growth performance. Although the specific mechanism of action of phytogenics is unknown, their favourable effects are explained by their antibacterial, immunomodulatory, and antioxidant properties (Kim 2010; Kim, 2013; Settle *et al.*, 2014). Recent research has shown that PFA can enhance feed efficiency (FE) and marginally increase breast production by regulating the expression of feeding-related hypothalamic neuropeptides (Orlowski *et al.*, 2018; Flees *et al.*, 2020). Bioactive substances like as thymol, carvacrol, cineole, and capsaicin are responsible for the wide range of favourable advantages of phytogenic feed additives. With all of these advantages, phytogenic feed additives may be ideal natural alternatives to conventional antibiotic growth promoters (AGP) diet supplements. This study aims to determine growth performance, serum metabolites, plasma protein fraction, meat lipid profile and antioxidant activities of meat of broilers as affected by *Cinnamomum ceylon*, *Zingiber officinale* and *Moringa oleifera* supplementation.

2. Materials and methods

Location and experimental site: The study was conducted in the Poultry Unit of Teaching and Research Farm, Department of Agricultural Technology, Federal Polytechnic Ado Ekiti, Ekiti State, Nigeria. Ekiti state is located in the country's south-western region. It has a land area of 6353 km^2 (2453 sqm) and a population of 2737,186 according to 2005 estimates. It has tropical weather with two distinct seasons: wet (April to October) and dry (November to March). Ado Ekiti's temperature varies from 21^0C to 28^0C, with considerable humidity.

Site preparation: The poultry house was thoroughly washed and fumigated with disinfectant, then left to dry for two weeks before the arrival of the experimental birds. Additionally, the surrounding area was properly weeded to prevent the presence of predators and pests.

Experimental animals: A total number of one hundred and twelve (112) day old birds of commercial breed were used in this experiment. There were 4 treatments replicated 4 times with 7 birds per replicate amounting (28) birds per treatment. Normal vaccinations were given to the experimental birds.

Test ingredients: The test ingredients Cinnamon *(Cinnamomum ceylon) and* Ginger *root (Zingiber officinale)* used were gotten from a local market in Ado Ekiti while *Moringa oleifera* leaf meal were harvested within the premises of The Federal Polytechnic Ado Ekiti, ginger was sliced, air-dried for 7 days, while Moringa *oleifera* leafmeal was air-dried for a period of 7 days, in order to reduce the moisture content. They were milled into fine particles and used to formulate the diets.

Management of experimental birds: The birds used in this investigation was sourced from a reputable hatchery. The chicks were brooded for two weeks to acclimatise, with electric lights providing light and warmth in the enclosure. The brooder house had enough room ventilation and polythene coverings were utilized to keep it warm while also protecting it from predators and extreme cold weather. The chicks were fed the experimental diets from day one to the end of feeding trial. Proper and acceptable management methods were implemented, including necessary vaccines. Throughout the trial, feed and water were freely available.

Experimental diets: The composition of experimental diets are presented in Tables1 and 2. The basal diets were formulated for broiler starter (0-28) days and finisher phase (29-56) days. The basal diets were divided into 4 diets: diet 1 – control diet without supplementation; diet 2 – 0.2% of *Cinnamomum ceylon* supplementation (CCS) ; diet 3 – 0.2% of *Zingiber officinale* supplementation (ZOS) ; diet 4 – 0.2% of *Moringa oleifera leaf meal* (MLM) supplementation.

Table 1 Composition of experimental diets (%) for broiler starter

Ingredients	**1**	**2**	**3**	**4**
CCS	-	0.2	-	-
ZOS	-	-	0.2	-
MOLM	-	-	-	0.2
Maize	49	49	49	49
Soyabean cake	24	24	24	24
Groundnut cake	18	18	18	18
Fish meal	2	2	2	2
Bone meal	3	3	3	3
Limestone	2	2	2	2
Broiler premix	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Vegetable oil	1	1	1	1
Total	100	100	100	100
Calculated composition				
Metabolizable energy(Kcal/kg)	2820	2820	2820	2820
Crude Protein (%)	23.5	23.5	23.5	23,5
Average calcium	1.99	1.99	1.99	1.99
Average phosphorus	0.84	0.84	0.84	0.84
Lysine	1.27	1.27	1.27	1.27

Table 2 Composition of experimental diets (%) for broiler finisher

Ingredients	**1**	**2**	**3**	**4**
CCS	-	0.2	-	-
ZOS	-	-	0.2	-
MOLM	-	-	-	0.2
Maize	53	53	53	53
Soyabean cake	22	22	22	22
Groundnut cake	16	16	16	16
Fish meal	2	2	2	2
Bone meal	3	3	3	3

Limestone	2	2	2	2
Broiler premix	0.25	0.25	0.25	0.25
Methionine	0.25	0.25	0.25	0.25
Lysine	0.25	0.25	0.25	0.25
Common salt	0.25	0.25	0.25	0.25
Vegetable oil	1	1	1	1
Total	100	100	100	100
Calculated composition				
Metabolizable energy(Kcal/kg)	2980	2980	2980	2980
Crude Protein (%)	21.8	21.8	21.8	21.8
Average calcium	1.96	1.96	1.96	1.96
Average phosphorus	0.69	0.69	0.69	0.69
Lysine	1.33	1.33	1.33	1.33

Experimental design: The experimental design used was Completely Randomized Design (CRD) with a total number of 16 experimental units. 4 treatments which were replicated 4 times with 7 birds per replicate. The total number of birds used in this study was one hundred and twelve (112) broiler chicks.

Data collection: The birds in each pen were weighed on weekly basis and feeding intake was recorded on weekly basis, the following parameters were taking: feed intake, daily weight gain, feed conversion ratio. Feed intake was calculated as the difference in initial weight of the feed given and the residual feed to obtain average weekly feed intake, body weight gain was obtained by subtracting the initial weight from the final weight. Feed conversion ratio: the feed conversion ratio (FCR) was calculated by dividing feed intake by weight gain of the birds.

Blood samples collection was done in the morning after the birds were starved overnight in order to obtain a stable serum evaluation, four birds were randomly selected from each treatment and blood samples was collected from jugular veins at the termination of the experiment. The blood samples meant for serum metabolite were collected in plain bottles without anticoagulants and was analyzed in the laboratory. The tube was kept in a slanting wooden rack and the blood samples were allowed to clot overnight. The serum samples were kept deep frozen prior to analysis to determine Urea as described by Kaplan and Szabo (1979), total cholesterol as outlined by Roschlan *et al.*, (1974), high density lipoprotein and low density lipoprotein were also determined. The plasma protein samples were kept deep frozen prior to analysis to determine total protein, globulin and albumin. The albumin/globulin ratio was calculated. Fifty grams (50g) of meat samples were collected each from the breast region of birds selected for carcass characteristics for the determination of total cholesterol as outlined by Allain *et al.* (1974), triglyceride, high-density lipoprotein (HDL) and low density lipoprotein (LDL). 50g of the meat excised from breast meat were also used for determination of antioxidant activities such as catalase activity as described by Hadwan and Khabt, 2018; glutathione peroxide as outlined by Cichoski *et al.*(2012), superoxide dismutase and lipid peroxidation as outlined by (Bostoglou *et al.*,1994).

Statistical Analysis: All data collected in this study were subjected to Analysis of Variance using SPSS. Duncan's Multiple Range test of one-way ANOVA was used to analyze the mean differences of the same parameter. Significant differences were considered where necessary at a level of (P>0.05).

3. Results

The result of the effect of phytogenic supplemented diets on growth performance of broiler chicken is shown in Table 3. There were significant differences in final live-weight, body weight gain, feed intake and feed conversion ratio among treatments (P<0.05). The highest final live-weight (FLW) was recorded for birds fed 0.2% *Moringa oleifera* leafmeal supplemented diet at 2844.05g while the least FLW was recorded for birds on 0.2% *Cinnamomum ceylon* supplemented diet at 2701.82g. The body weight gain (BWG) of birds on control diet and 0.2% ginger root supplemented diet were similar (P>0.05) but significantly lower than the values recorded for birds on 0.2% *Moringa oleifera* leafmeal supplemented diet. The feed intake (FI) of birds on control diet and 0.2% *Cinnamomum ceylon* supplemented diet were similar (P>0.05) but significantly lower than the values recorded for birds on 0.2% ginger root and 0.2% *Moringa oleifera* leafmeal supplemented diets. The value of feed conversion ratio (FCR) of birds on control diet was significantly lower (P<0.05) than the values recorded for birds on treatment groups.

Table 3 Effect of herbal supplements on growth performance of broiler chickens

Parameters					**SEM**	***p- value***
	T1	T2	T3	T4		
	0%	0.2% CCS	0.2%ZOS	0.2%MOLM		
Initial live-weight (g)	33.30	35.38	35.68	35.33	0.39	0.11
Final live-weight (g)	2760.90^{c}	2701.82^{d}	2805.33^{b}	2844.05^{a}	16.07	0.01
Weight gain (g)	41.07^{b}	38.62^{c}	40.38^{b}	43.02^{a}	0.49	0.01
Feed intake (g)	64.07^{c}	63.91^{c}	66.83^{b}	70.45^{a}	0.81	0.01
FCR	1.54^{c}	1.63^{ab}	1.66^{a}	1.61^{b}	0.01	0.01

a,b means in the same row with different superscript are significantly different (p<0.05); FCR-feed conversion ratio

The effect of phytogenic supplements on serum metabolites of broiler chickens are shown in Table 4. The urea values in the birds fed 0.2% *Cinnamomum ceylon* supplemented diet were significantly (P<0.05) lower than the value recorded for birds fed other diets. The cholesterol and low density lipoprotein values of birds on 0.2% *Cinnamomum ceylon* supplemented diet, 0.2% ginger root supplemented diet and 0.2% *Moringa oleifera* leafmeal supplemented diet were similar (P>0.05) but significantly lower than the values recorded for birds fed control diet. The glucose and high density lipoprotein were not influenced by the experimental diets

Table 4 Effect of herbal supplements on serum metabolites of broiler chicken

Parameters					**SEM**	***p- value***
	T1	T2	T3	T4		
	0%	0.2%C CS	0.2%ZOS	0.2%MOLM		
Urea (mg/dl)	1.42^{a}	0.44^{b}	0.72^{ab}	1.13^{ab}	0.16	0.10
Cholesterol (mol/l)	4.50^{a}	3.10^{b}	3.90^{b}	3.10^{b}	0.10	0.04
Glucose	12.17	8.95	9.45	10.85	0.55	0.15
HDL	2.15	1.85	1.90	2.15	0.07	0.26
LDL	2.30^{a}	1.85^{b}	1.55^{b}	1.67^{b}	0.10	0.02

a,b …means in the same row with different superscript are significantly different (p<0.05). HDL: High density lipoprotein;LDL:Lowdensity lipoprotein

Table 5 presents the total protein, albumin, globulin, and albumin/globulin ratio of birds fed varied phytogenic supplements of 0.2% *Cinnamomum ceylon,* 0.2% ginger root, and 0.2% *Moringa oleifera leaf meal*. The values of total protein, albumin and globulin of birds on 0.2% CCS, 0.2%GS and 0.2% MOLM were similar (P>0.05) but significantly (P<0.05) higher than the values recorded for birds on control diet. The value of albumin/globulin ratio of birds on 0.2% CCS, 0.2% GS and 0.2% MLM were similar (P>0.05) but significantly (P<0.05) lower than the values of birds on control diet.

Table 5 Effect of herbal supplements on plasma protein fraction of broiler chickens

Parameters					SEM	*p- value*
	T1	T2	T3	T4		
	0%	0.2%CCS	0.2%ZOS	0.2%MOLM		
Total protein (g/l)	37.57^{b}	42.02^{a}	41.73^{a}	41.63^{a}	0.57	0.01
Albumin (g/l)	18.25^{b}	18.56^{a}	18.59^{a}	18.58^{a}	0.04	0.01
Globulin (g/l)	21.06^{b}	22.05^{a}	22.07^{a}	22.07^{a}	0.23	0.01
Albumin/ Globulin ratio	0.86^{a}	0.84^{b}	0.83^{b}	0.83^{b}	0.01	0.01

a,b, means within the same row with different superscript are significantly different (p<0.05).

Table 6 presents the cholesterol, triglycerides and LDL values recorded for birds on diets 2, 3 and 4 were similar (p>0.05) but significantly (p<0.05) lower than the values recorded for diet 1(control diet). The cholesterol, triglycerides and LDL values were recorded for birds on diet 4 at 3.31, 1.25, 2.23, 1.66 respectively. The High Density Lipoprotein values of birds on diets 2, 3 and 4 were similar (P>0.05) but significantly (P<0.05) higher than control diet.

Table 6 Effect of herbal supplements on breast meat lipid profile of broilers

Parameters					SEM	*p- value*
	T1	T2	T3	T4		
	0%	0.2% CCS	0.2%ZOS	0.2%MOLM		
Cholesterol (mmol)	4.00^{a}	3.35^{b}	3.20^{b}	3.31^{b}	0.03	0.01
Triglycerides	4.20^{a}	1.21^{b}	1.15^{b}	1.25^{b}	0.30	0.01
HDL	1.50^{b}	2.20^{a}	2.35^{a}	2.23^{a}	0.12	0.05
LDL	2.19^{a}	1.71^{b}	1.61^{a}	1.66^{b}	0.08	0.01

^{a,b} means in the same row with different superscripts are significantly (p<0.05) different; SEM: Standard; Error of the Mean. HDL: High density lipoprotein, LDL: Low density lipoprotein

The effects of phytogenic supplement on catalase (CAT), glutathione peroxidase (GPx), superoxide dismutase (SOD) and lipid peroxidation of the breast meat were shown in table 7. The catalase activity was not affected (P>0.05) by dietary treatment. The GPx activities were significantly (P<0.05) increased in diets 2, 3 and 4. The highest GPx was recorded in breast meat from the birds fed 0.2% ZOS .The values recorded for SOD activity were not affected (P>0.05) by the phytogenic supplements though the values recorded for breast meat from birds fed diets 2, 3 and 4 were higher than the value recorded for breast meat of birds fed control diet. The lipid peroxidation values of breast meat from birds fed 0.2% CCS and 0.2% MOLM were similar (P>0.05) but significantly (P<0.05) higher than the values recorded for breast meat from birds fed 0.2% ZOS. The highest value of lipid peroxidation was recorded in breast meat from birds fed control diet at 15.62 while the least value was recorded in breast meat from birds fed 0.2% ZOS at 5.67mgMDA/100g.

Table 7 Effect of herbal supplements on antioxidant activities of breast meat of broilers

Parameters					SEM	*p- value*
	T1	T2	T3	T4		
	0%	0.2% CCS	0.2%ZOS	0.2%MOLM		
Catalase (μ/ml)	112.84	114.38	115.07	113.97	12.86	0.87
GPx (mg/ml)	138.34^{b}	166.84^{a}	167.89^{a}	165.92^{a}	12.42	0.02
SOD (%)	0.95	1.31	1.10	1.16	0.13	0.84
Lipid peroxidation	15.62^{a}	8.02^{b}	5.67^{c}	7.57^{b}	1.26	0.01

a,b,c means within the same row with different superscript are significantly different (p<0.05): SEM standard error of mean; GPx-glutathione peroxidase; SOD- superoxide dismutase

4. Discussion

In this study, the observed improved final liveweight, weight gain, and feed intake of the experimental diets fed 0.2% MOLM supplemented diets could be due to the bioactive compound (tocopherols γ and α, phenolic compounds, and β-carotene) could have contributed to the improved final liveweight, weight gain, and feed intake of the diets recorded for the birds fed 0.2% MOLM (Valenzuela-Grijalva *et al.*, 2017). Furthermore, phytochemicals have been shown to have anabolic effects and affect the animal's metabolism, influencing muscular tissue growth (Gonzalez-Rios *et al.*, 2016). Studies on the influence of phytogenic feed additives on broiler growth performance yielded inconsistent results. The current study contradicts the findings of (Windisch *et al.*,2008), who indicated that experimental results in birds revealed lower feed intake with insignificant change in body weight increase, resulting in an enhanced feed conversion ratio (FCR). The inclusion of MOLM may have influenced the taste and aroma of the diet by the quality of having a sharp strong smell of the MOLM, the feed intake of birds increased. The current study found that after birds on control diet, birds fed 0.2% MOLM had an FCR of 1.61 in the experimental group. Among the phytogenic feed additives, MOLM enhanced FCR, corroborating the findings of (Windisch *et al.*, 2008). This study contradicted previous findings (Mountzouris *et al.*, 2011), which showed that phytogenic feed additive supplementation improved daily weight gain and FCR while having no effect on daily weight gain or feed consumption.

When compared to birds on a control diet, birds on phytogenic feed additive enriched meals had similar levels of urea, showing that the active compounds in CCS, ZOS and MOLM lowered urea levels. This shows that the phytogenic supplements used in this investigation did not impair the birds' renal function (Peters and Susan, 1991). A high serum cholesterol level induces cholesterol to accumulate on arterial walls, resulting in plaques that restrict the artery lumen and delay blood flow to the heart. Because unusually high blood cholesterol levels are linked to arteriosclerosis and premature mortality in broilers. (Olkowski *et al.*, 2007), CCS, ZOS and MOLM have antilipidemic effects. As a result, the lower blood cholesterol concentrations seen in birds fed phytogenic-supplemented meals in this study are beneficial to their health. The reduced gut absorption of cholesterol observed in this trial could be attributed to the actions of second metabolites, such as saponin found in CCS, ZOS and MOLM, which promote this reduction via an intra-luminal physicochemical interaction (Oloruntola *et al.*, 2018a). Low levels of low density lipoprotein were detected in the blood of birds fed diets 2, 3, and 4. Because their primary purpose is to transport cholesterol to both peripheral and hepatic cells, low density lipoprotein is the primary transporter of cholesterol in blood. Low levels of low density lipoprotein in the present study reduced the risk of developing arteriosclerosis (Peters and Susan, 1991). The phytogenic supplements had no impact on glucose or HDL.

Birds administered phytogenic supplements exhibited much greater plasma albumin levels. However, plasma globulin levels were higher, as was total protein, and there was no obvious difference between the birds given different phytogenic supplements, suggesting that broilers may have a better immune response to the phytogenic supplement. It has been claimed that a bird's plasma protein profile reflects the metabolic processes involved in protein generation or breakdown. Since it is commonly known that stress can cause the adrenal cortex to produce corticosterone, which dramatically enhances protein catabolism due to its gluconeogenic action (Toliba and Hassan, 2003). Dietary supplementation with phytogenic feed additives significantly enhanced plasma total protein levels, corresponding with the findings of Teye *et al.* (2013). According to Melesse *et al.* (2013), higher total protein levels in birds fed phytogenic supplements might be attributed to more broad protein metabolism in the birds' organs.

Consumers are concerned about the type of cholesterol and fatty acids they eat because of the known link between excessive cholesterol and saturated fat intake and an increased risk of developing ailments such as high blood pressure, heart disease, and obesity. The reduced meat cholesterol, triglycerides, and low density lipoprotein levels observed in birds fed CCS, ZOS and MOLM supplemented diets compared to those fed the control diet in this study could be attributed to an interaction with the phytogenic supplements that reduced the aforementioned parameters. However, the lower levels of meat cholesterol, triglycerides, and low density lipoprotein found in these birds are beneficial to health because high cholesterol meat consumption is related with several health complications.

Triglycerides are the most prevalent form of fat in the body, and they store extra energy from the food. High triglyceride levels, along with high LDL (bad cholesterol or low HDL) good cholesterol, have been related to fatty buildups inside artery walls, increasing the risk of heart attack and stroke. Because individuals are more aware of what they eat, the phytogenic supplement reduced broiler chicken triglyceride levels. High density lipoprotein (HDL) cholesterol, sometimes known as "good" cholesterol, absorbs cholesterol from the blood and transports it back to the liver. The liver then flushes it out of the body. High HDL cholesterol levels can minimize the risk of heart disease and stroke in consumers (Marz *et al.*, 2017). LDL (Cholesterol) is called "bad" cholesterol because it contributes to fatty accumulation in the arteries. This narrows the arteries and raises the risk of heart attacks, strokes, and peripheral arterial disease...The phytogenic supplement is minimal and has no deleterious impact on the meat (Dashti *et al.*, 2011).

The oxidative process that happens throughout meat's shelf life may impair its nutritional and sensory properties (Kumar *et al.*, 2015). As a result, strategies that stimulate the avoidance of lipid and protein oxidation will increase the useable and shelf life of beef. This is because the growth of lipid oxidation promotes physiological function loss, membrane property change, enzyme deactivation, denaturation, and rupture, all of which contribute to cellular component leakage (Bekhit *et al.* 2013). Natural antioxidants in animal production have recently been explored (Brewer, 2011) to enhance animal health and meat shelf life by boosting oxidative status antimere while preventing antioxidant deposition in the meat over the animals' lifetimes (Descalzo and Sancho, 2008). Catalase and glutathione peroxidase must be present for hydrogen peroxide (H2O2) elimination to occur. The increased glutathione peroxidase concentration found in the meat of birds fed the study's supplemented diets of cinnamon, garlic, and moringa leaf meal suggested that these phytogenic supplements could alter the antioxidant enzymes in the muscular system, increasing the meat's shelf life (Bekhit *et al.*, 2013). The inclusion of phytogenic supplements in animal diets during production may reduce lipid peroxidation activities and, as a result, improve meat shelf life, as evidenced by the lower lipid peroxidation activities in the meat of birds fed phytogenic supplements in this study (Valenzuela-Grijaiva *et al.*, 2017). The low level of lipid peroxidation seen in meat from broilers given 0.2% ginger powder might be attributed to the presence of bioactive components in the ginger powder.

5. Conclusion

Moringa oleifera leaf meal (MOLM) contains rich bioactive compounds with a strong antioxidant capacity to scavenge free radical. It is also observed in this study that supplementation of broiler diets with Moringa oleifera leaf meal enhanced body weight gain, reduce cholesterol level in both serum and meat.

Recommendation

It could be recommended that dietary supplementation of MLM enhanced weight gain, maintain health status and improve meat quality of the broiler chickens.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Allain, C.C., Poon, L.S., Chan, C.S.G, Richmond, W. and Fu, P.C. Enzymatic determination of total serum cholesterol. *Clinical Chemistry*. 1974; 20 (Suppl 4): 470-475.

[2] Amad A.A., Manner K., Wendler K.R., Neumann K., and Zentek J. Effects of a phytogenic feed additive on growth performance and ileal nutrient digestibility in broiler chickens. *Poultry Science*. 2011; 90:2811–2816.

[3] Arshad MS, Anjum FM, Khan MI, Saeed F, Imran A and Sohaib M. Manipulation of natural antioxidants in feed to enhance the oxidative stability and quality of broiler breast meat and nuggets. *Journal of Food Processing and Preservation*. 2016; 41: e12849.

[4] Bekhit, A.E.A., Hopkins, D.L., Falii, F.T and Ponnampalam, E.N. Oxidative processes in muscle system and fresh meat; sources, markers and remedies. Comprehensive Review of Food Science and Food Safety. 2013; 12, 565-597. http: 1112;doi; -10-1111/1541-4337, 12027.

[5] Berzaghi P, Dalle Zotte A, Jansson LM and Andrighetto I. Near-infrared reflectance spectroscopy as a method to predict chemical composition of breast meat and discriminate between different n-3 feeding sources. *Poultry Science*. 2005; 84: 128-136.

[6] Brewer, M.S. Natural antioxidant sources, Compounds, Mechanism of action and potential applications. Comprehensive review of Food science and food safety. 2011; 10: 221-247.

[7] Botsoglou, N.A ., Fletouris, D.J., Papageorgiou, G.E., Vassilopoulos, V.N., Mantis, A.J and Trakatellis, A. Rapid, sensitive and specific thiobarbituric and method for measuring lipid peroxidation in animal tissue, food and feedstuff samples. *Journal Agriculture and Food Chemistry.* 1994; 42: 1931-1937.

[8] Cichoski, A.J, Rotta, R.B, Scheuermann,G., Junior, A.C and Barin, J.S. Investigation of glutathione peroxidase activity in chicken meats under different experimental conditions. *Clinical Technology* Alliment Camping. 2012; 32(4) 661-667.

[9] Dashti M, Kulik W, Hoek F, Veerman EC, Peppelenbosch MP, and Rezaee F. "A phospholipidomic analysis of all defined human plasma lipoproteins". *Sci. Rep*. 2011; 1 (139):139. Bibcode:2011NatSR...1E.139D. doi:10.1038/srep00139. PMC 3216620. PMID 22355656.

[10] Descalzo A.M and Sancho, A.M. A review of natural antioxidant and their effects on oxidative status, odour and quality of fresh beef produced in Argentina. *Meat science*. 2008; 79: 423-436.

[11] Diaz-Sanchez S, D'Souza D, Biswas D, Hanning I. Botanical alternatives to antibiotics for use in organic poultry production. Poultry science. 2015; 1;94(6):1419-30.

[12] Flees J., Greene E., Ganguly B., and Dridi S. Phytogenic feed- and water-additives improve feed efficiency in broilers via modulation of (an)orexigenic hypothalamic neuropeptide expression. Neuropeptides, 2020; 81:102005.

[13] Gonzalez-Rios, H., Davila-Ramirez, J.L., Pena-Ramos, E.A., Valenzuela-Melendres, M., Zamorano-Garcia, L., Islava-Lagarda, T.Y., Valenzuela- Grijalva, N.V. Dietary supplementation of ferulic acid to steers under commercial feedlot feeding conditions improves meat quality and shelf life. *Animal Feed Science and Technology*. 2016; 222:111-121.

[14] Hadwan, M.H and Khabt, H. Simple spectrophotometric method for analysis of serum catalase activity. *Journal of clinical and diagnostic Research.* 2018; 12 (9) BC13-BC16.

[15] Haque M. H., Sarker S, Islam M. S, Islam M. A, Karim M. R, Kayesh M. E. H., Shiddiky M. J. A. and Anwer M.S. Sustainable antibiotic-free broiler meat production: Current trends, challenges, and possibilities in a developing country perspective. *Biology*. 2020; 9: 411.

[16] Kaplan, A; and Szabo, L.L. Clinical Chemistry: Interpretation and Technique. London: Henry Kumpton Publishers, London. 1979.

[17] Kim D.K., Lillehoj H.S., Lee S.H., Jang S.I., and Bravo D. High-throughput gene expression analysis of intestinal intraepithelial lymphocytes after oral feeding of carvacrol, cinnamaldehyde or Capsicum oleoresin. *Poultry Science*. 2010; 89: 68 – 81.

[18] Kim D.K., Lillehoj H.S., Lee S.H., Lillehoj E.P., Bravo D. Improved resistance to Eimeria acervulina infection in chickens due to dietary supplementation with garlic metabolites. *British Journal of Nutrition*. 2013; 109:76–88.

[19] Kumar, G., Sinha, A.K., Choudhary, P.K., Robeston, A., Kumar, R. Effect of replacement of groundnut cake with Niger seed cake on serum biochemical profile and protein efficiency ratio in broiler chicken. *Journal interacademicia.* 2015; 19 (1): 82-87.

[20] Marchi, S., Giorgi, C., Suski, J.M., Agnoletto, C., Bononi, A., Bonora, M., De Marchi, E., Missiroh, S., Patergnani, S., Polelti, F., Rimessi, A., Duszynski, J., Wieckowski, M.R and Pinton, P. Mitochondria-Rus cross talk in the control of cell death and agent. *Journal of signal Transduction*. 2012; 4, 329635: http://doi:10.1155/2012/329631.

[21] Ma´the´ A´. Essential oils as phytogenic feed additives. (eds). In: Franz C, Ma´the´ A´ , Buchbauer G. Essential oils: basic and applied research. *Allured Publishing Corporation, Carol Stream*, (2007). pp:315–325.

[22] Marz Winfried, Marcus E. Kleber, Hubert Scharnag, Timotheus Speer, Stephen Zewinger, Andreas Ritsch, Klaus G. Parhofer, Arnold Vom Eckardstein Ulf Landmesser, Ulrich Laufs. (2017). HDL cholesterol: reappraisal of its clinical relevance. *Clinical Resource Cardiology*. 2017; 106: 663-675.

[23] Melesse, A., Steingass, H., Boguhn, J., Rodehutscord, M. In vitro fermentation characteristics and effective utilizable crude protein in leaves and green pods of *Moringa stenopetala* and *Moringa oleifera* cultivated at low and mid-altitudes. *Journal of Animal Physiology and Animal Nutrition*. 2013; 97 (30): 537-546.

[24] Mountzouris K. C, Paraskeuas V, Tsirtsikos P, Palamidi I, Steiner T, Schatzmayr G, and Fegeros K. Assessment of a phytogenic feed additive effect on broiler growth performance, nutrient digestibility and caecal microflora composition. *Animal Feed Science and Technology*. 2011; 168: 223- 231.

[25] Oloruntola, O.D., Agbede, J.O., Ayodele, S.O and Oloruntola, D.A. Neem, pawpaw and bamboo leafmeal dietary supplementation in broiler chickens : effect on performance and health status. *Journal of Food Biochemistry*. 2018; 43 (2), e 12723. DOI: http: // doi.org/10.1111/jjfbc.12723.

[26] Orlowski S., Flees J., Greene E.S., Ashley D., Lee S.O., Yang F.L., Owens C.M., Kidd M., Anthony N., and Dridi S. Effects of phytogenic additives on meat quality traits in broiler chickens1. *Journal Animal Science*. 2018; 96:3757–3767.

[27] Peter, M.L and Susan, C.E. F. (1991). Interpretation of laboratory results. Australian Veterinarian Practitioner, 21 (4), 188-193.

[28] Riovanto R.D.E., Marchi M., Cassandro M and Penasa M. Use of near infrared transmittance spectroscopy to predict fatty acid composition of chicken meat. *Food Chemistry*. 2012; 134: 2459-2464.

[29] Roschlan, P., Bernet E. and Gruber, W. Enzymatische bestimmung des gesamt cholesterium in serum. *Journal of Clinical Biochemistry*. 1974; 12: 403-407.

[30] Roth N, Käsbohrer A, Mayrhofer S, Zitz U, Hofacre C and Domig KJ. The application of antibiotics in broiler production and the resulting antibiotic resistance in Escherichia coli: *A global overview. Poultry Science*, 2019; 98: 1791-1804.

[31] Santhi D, Kalaikannan A and Natarajan A. Characteristics and composition of emulsion-based functional low-fat chicken meat balls fortified with dietary fiber sources. *Journal of Food Process Engineering*. 2020; 43: 1-12.

[32] Settle T., Leonard S.S., Falkenstein E., Fix N., Van Dyke K., and Klandorf H. Effects of a phytogenic feed additive versus an antibiotic feed additive on oxidative stress in broiler chicks and a Possible mechanism determined by Electron Spin Resonance. *International Journal of Poultry Science.* 2014; 13:62–69.

[33] Upadhaya, S. and Kim, I. Efficacy of Phytogenic Feed Additive on Performance, Production and Health Status of Monogastric Animals – A Review. Annals of Animal Science. 2017; 17. 10.1515/aoas-2016-0079.

[34] Valenzuela-Grijalva, N.V., Pinelli- Saavedra, A., Muhlia-Almazan, A., Dominguez-Diaz, D., and Gonzalez-Rios, H. Dietary inclusion effects of phytochemicals as growth promoters in animal production. *Journal of Animal Science and Technology*. 2017; 59, (8) 1-17 Doi:http://doi.org/10.1186/s40781-071-0133-9.

[35] Velasco and Williams, P. Improving meat quality through natural antioxidant. *Chilean Journal of Agricultural Research*. 2011; 71, 313-322.

[36] Windisch, W., Schedle, K., Plitzner, C., Kroismayr, A. Use of phytogenic products as feed additives for swine and poultry. *Journal of Animal Science*. 2008; 86: 140-8. https://doi.org/10.2527/jas.2007-0459.