Original Research

Effect of Dietary Supplementation of Graded Levels of Monosodium Glutamate (MSG) on Growth Performances, Intestinal Micro Flora, Blood Profile and Organs Histology in Broiler Chickens

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Abstract

This study was undertaken to know the effects of dietary Monosodium Glutamate (MSG) on growth performances of broiler chickens. Three hundred twenty day-old Ross 308 chicks were randomly divided to 5 treatment groups of 64 chicks each. Negative and positive control groups were fed on basal diet without supplement (R0-) and 1g of antibiotic (R0+) respectively and the 3 others groups were fed on diets supplemented with 1 mg, 2 mg and 4 mg of MSG/kg of feed. Results revealed that feeding broilers with MSG decreased ($p<0.05$) FI at the starter phase with an upward trend at the finisher phase. Diet supplemented with 2 mg of MSG/kg increased ($p<0.05$) LBW and WG, and decreased FCR. MSG significantly ($p<0.05$) increased lactic acid bacteria counts as compared to E. coli and Salmonella. Hematological parameters and histology of organs were not affected while serum content in protein, globulin, triglyceride, total cholesterol and urea markedly increase. It was concluded that 2 mg of MSG/kg could be used as feed additive to improve growth performance and mitigate the public concern about bacteria resistance issues as well as antibiotics residues in broiler chickens.

Key words: Broiler Chickens, Feed Additive, Growth Promoter, Monosodium Glutamate

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Introduction

Due to the bacterial resistance issues as well as the increasing public concern about antibiotics residues in animal products, research has been focused to find natural alternatives to antibiotics feed additives. The most investigated alternatives include probiotics and prebiotics (Tuohy *et al.*, 2005), organic acids and enzymes (Gunal *et al.*, 2004; Yang *et al*., 2009), spices (Kana *et al.*, 2017), essential oils (Ngouana *et al.*, 2017), metals ions such as silver (Dongwei *et al.*, 2009; Yemdjie *et al.*, 2017) and amino acid salt such as monosodium glutamate (Khadiga *et al.*, 2009; Gbore *et al.*, 2016).

Monosodium glutamate (MSG) is the sodium salt of glutamic acid and the main component of many proteins (Tawfik and Al-Badr, 2012). Glutamate is an acidic amino acid with multiple roles in cell metabolism and physiology. This nutrient participates in both synthetic and oxidative pathways in tissues (Blachier *et al*., 2009), serves as a major energy substrate for the small intestine (Burrin and Stoll, 2009), an excitatory neurotransmitter and activator of taste receptors in the digestive tract (Kirchgessner, 2001). It has been widely used for many years in human diets as flavor enhancer to promote consumption rates of a particular food (Parshad and Natt, 2007). Although, MSG could improve the palatability of foods by exerting a positive influence on the appetite centre, it positively impacts on body weight gains (Egbuonu *et al.*, 2010). However, some authors incriminated MSG as cause of some negatives responses, which could be attributed to ingestion of large doses by individuals hypersensitive to MSG (Tarasoff and Kelly, 1993). Despite evidence of negative consumer response to large amount of monosodium glutamate, many reputable internationals organizations and nutritionists continued to endorse monosodium glutamate, and reiterated that monosodium glutamate has no adverse reactions in humans. MSG has been declared as completely harmless at usual doses and that the cases of intolerance reported are difficult to be attributed to this molecule since it is chemically identical to glutamate found in food and is metabolized in the same way (Samuels, 1999). With the evidence of its ability to enhance human's food flavor, MSG might be used as feed additive in animal diets to stimulate feed intake with positive impact on growth performances and finally to mitigate the public concern about drug residues and others side effects of antibiotics feed additives in livestock products. The aim of the present study was to assess the effect of dietary graded levels of MSG on growth performances, intestinal microbial counts, hemato-biochemical and histological parameters of broilers chickens.

Materials and Methods

Site of Study

The study was conducted at the poultry unit of the Teaching and Research Farm of the University of Dschang, Cameroon. This farm is located at 5°26' North and 10°26' East at an altitude of 1420 m above

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sea level. Annual temperatures vary between 10°C and 25°C. Rainfall ranges from 1500 to 2000 mm per annum over a 9 months rainy season (March to November).

Animals

Three hundred twenty day-old Ross 308 broiler chicks were procured from a local hatchery and divided into 5 experimental groups of 64 chicks each. Each group was subdivided into four replicates of 16 chicks (8 males and 8 females in each replicate). Chicks were litter-brooded to 21 days old at a density of 20 chicks/m² and 10 chicks/m² to 49 days of age. Vaccination and other routine standard poultry management practices were maintained. Chicks were weighed at the beginning of the experiment and on a weekly basis thereafter. Feed and water were offered *ad libitum.*

Dietary Treatment and Experimental Design

Dietary treatments consisted of supplementing control diet (R0-) (Table 1) with 1g of Doxcyclin®/kg of feed as positive control (R0+), and 1mg, 2mg and 4mg of MSG /kg of diet. The monosodium glutamate (6.5g/ Ajinomoto sachet containing 99+% of MSG) was purchased from local market. Each experimental ration including the control was fed to 16 chicks (8 males and 8 females) replicated 4 times in a completely randomized design.

Table 1: Composition of experimental diets

Ingredients (g/kg)	Starter	Finisher
Maize	54	64
Wheat bran	5	1
Soybean meal	22	16
Cotton seed meal	5	5
Fish meal	5	5
Bones meal	1	1
Oeister Shell	1	1
Palm oil	2	2
Premix 5%*	5	5
Calculated Chemical Composition		
Metabolizable Energy (Kcal/kg)	2928.86	3042.76
Crude Proteins (g/kg)	23	20.4
Lysine (g/kg)	1.43	1.19
Methionine (g/kg)	0.48	0.44
Calcium(g/kg)	1.17	1.35
Phosphorus	0.53	0.56

**Premix 5%: crude proteins 400mg, Lysin 33mg, Methionin 24 mg, Calcium 80 mg, Phosphorous 20.5 mg, metabolizable energy 2078kcal/kg, Vitamins: Retinol 10 000 000 IU, Cholecalciferol 3 000 000 UI, Tocopherol 2500 IU, Phylloquinon 4000 mg, Thiamin 5000 mg, Riboflavin 500 mg, Pyridoxin 2500 mg, Cyanocobalamin 5 mg, Folic acid 10 000 mg and Niacin 2000 mg.*

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Growth, Hematological, Serum Biochemical and Histological Parameters

The feed intake (FI), weight gain (WG) and feed conversion ratio (FCR) were calculated on a weekly basis in both starter and finisher phases of the study. At 49 days old, 5 males and 5 females from each treatment group were randomly selected, fasted for 24h and slaughtered for carcass evaluation as proceeded by Kana *et al.* (2017). Blood for hematological analysis was collected in a test tube with anticoagulant. Hematological parameters including white blood cell (WBC), red blood cell (RBC), haemoglobin (Hb), haematocrit (HCT) and platelets (PLT) were analyzed using Genius electronic hematocymeter (Model KT-6180 S/N 701106101557). Meanwhile, blood for biochemical analysis collected in tube free from anticoagulant, was stored at room temperature and after 24 hours, the serum was collected and preserved at -20°C for the evaluation of serum content in protein, albumin, globulin, triglyceride, total cholesterol, HDL and LDL-cholesterol, Aspartate aminotransferase (AST), Alamine aminotransferase (ALT), urea and creatinine using Chronolab® commercial kits. Liver and kidney samples were randomly sliced from each treatment and fixed by immersion in formol solution for 1 week. Tissues were dehydrated in graded level of ethanol and xylene, and embedded in paraffin. Sections of 5µm were stained with hematoxylin-eosine for histological observations (40X magnification).

Microbial Count

At the end of the starter and finisher phases, faeces were collected in the cloaca using an antiseptic scovel from 4 birds per treatment. The number of colony of lactic acid bacteria, *Escherichia coli* and *Salmonella* were counted in an appropriate specific culture medium (MRS Agar for lactic acid bacteria, Mac Conkey Agar for *E. coli* and SS Agar for *salmonella* respectively) as proceeded by Pineda *et al.* (2012) .

Statistical Analysis

All data were submitted to analysis of variance using Statistical Package for Social Science (SPSS 20.0). Significant differences between treatment means were indicated using Duncan's Multiple Range test at 5% threshold significance (Vilain, 1999).

Results and Discussion

The present study revealed that supplementing broilers diets at the starter phase (1-21days) with MSG decreased ($p<0.05$) FI (Table 2). Similar results were reported by Khadiga *et al.* (2009) who supplemented broilers diets with 0.25 and 0.50% MSG. The decrease in FI with MSG could be the consequence of low digestive enzymes secretion in young chicks, which increased substantially from 21 days. Meanwhile, at the finisher phase (22-49 days) and all over the study period (1-49 days), 1mg of MSG/kg of diet significantly ($p<0.05$) increased FI. This result corroborated the findings of Khadiga *et al.* (2009) who reported a significant increase in FI with 1% MSG in broilers diet. Gbore *et al.* (2016) also reported an

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improvement of FI in rabbits fed with 1 mg, 2 mg and 4 mg of MSG /kg body weight. The increased in feed intake suggested that MSG enhanced flavor and the palatability of the food. This could be explained by the stimulation of brain cells involved in appetite by MSG (Jinap and Hajeb, 2010). Halpern (2000) and Moore (2003) also reported that in addition to the stimulation of the center of appetite, MSG improved feed palatability. This finding contradicted the result of Reza *et al.* (2012) who reported a significant decrease in FI of pigs fed on diet supplemented with 4% MSG. The present results contradicted the idea supported by Al-harthi (2006) and Abdel-Fatter *et al.* (2008) who reported that FI decreased with flavor enhancers like spices and organic acids as food additives to broilers diet.

At the finisher phase and all over the study period, chickens fed on diet supplemented with 2 mg of MSG/kg recorded the highest ($p<0.05$) LBW and WG compared to all other group including antibiotic (Table 2). This result was in agreement with the result of Gbore *et al.* (2016) who reported a significant improvement in growth performance of rabbits supplemented with 4 mg MSG /kg of body weight. Similarly, an increase in LBW was reported in rats treated with 15 and 30 mg MSG/kg body weight (Falalieieva *et al*., 2010). The improvement in LBW and WG recorded in the present study could be attributed to the multiple effects of MSG on the digestive tract which resulted in an increase in gastric and pancreatic secretions, better digestion and absorption of nutrients with improved growth performances as consequence (Burrin and Janeczko, 2008). MSG is transformed into α-ketoglutarate by transamination and its metabolism via the Krebs cycle producing coenzymes (NADH and $FADH_2$) used for energy production, which will be used in various metabolic reactions necessary for the growth process (Blachier *et al*., 2009).

Table 2: Effects of dietary MSG levels on growth performances of broiler chicks from 1 to 49 days old

Study Periods (days)	Control		MSG inclusion levels (mg/kg of diet)			
	R0-	R0+	1	2	4	*p-value*
Feed Intake (g)						
21-Jan	1201.72± 33.12^{a}	1125.48±27.23^{c}	1138.21±23.81^{bc}	1155.58±24.73^{b}	1177.21±13.74^{ab}	0.005
22-49	4383.46±211.55^{b}	4395.70±147.40^{b}	4890.62±205.19^{a}	4200.25±151.78^{b}	4456.85±104.62^{b}	0.001
Jan-49	5585.17±243.71^{b}	5521.18±123.31^{b}	6028.83±228.25^{a}	5355.83±169.96^{b}	5634.05±97.95^{b}	0.002
Live Body Weight (g)						
21-Jan	615.54±46.48^{c}	695.60±42.11^{a}	621.83±26.81^{c}	675.69±19.04^{ab}	627.54±11.78^{bc}	0.009
Jan-49	2117.45±13.55^{d}	2548.93±63.96^{b}	2519.38±16.38^{b}	2700.57±39.88^{a}	2245.09±34.16^{c}	0
Weight Gain (g)						
21-Jan	575.80±46.48^{c}	655.86±42.11^{a}	582.09±26.81^{c}	635.95±19.04^{ab}	587.80±11.78^{bc}	0.009
22-49	1501.91±36.80^{d}	1853.33±36.43^{b}	1897.55±37.34^{b}	2024.89±28.09^{a}	1617.54±33.65^{c}	0
Jan-49	2077.71±13.55^{d}	2509.19±63.96^{b}	2479.64±16.38^{b}	2660.83±39.88^{a}	2205.35±34.16^{c}	0
Feed Conversion Ration (FCR)						
21-Jan	2.10±0.21^{a}	1.73±0.15^{c}	1.96±0.05^{ab}	1.82±0.04^{bc}	2.00±0.02^{ab}	0.005
22-49	2.92±0.07^{a}	2.37±0.08^{d}	2.58±0.15^{c}	2.08±0.10^{e}	2.76±0.06^{b}	0
Jan-49	2.69±0.13^{a}	2.20±0.04^{c}	2.43±0.10^{b}	2.01±0.08^{d}	2.56±0.04^{ab}	0

a, b, c, d, e: on the same line values affected with different letter differ significantly ($P<0.05$). R0- = negative control ration. $R0^{+}$: $R0^{-}$ + 1g/kg Doxycyclin® ; p= probability.

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Feeding broilers with 2 mg of MSG markedly ($p<0.05$) decreased FCR as compared to all others treatments including antibiotic at the finisher phase and all over the study period (Table 2). The present result was similar to the findings of Kana *et al.* (2017) who recorded a significant decrease in FCR with 0.2% *D. glomerata* (spice) used as growth promoter in broilers diet. Similarly, Rahimian *et al.* (2016) reported a significant drop in FCR with 0.2% of black pepper. The decrease of FCR indicated that digestibility of feed and absorption of the resulted nutrients were better with diets supplemented with 2 mg of MSG/kg. Indeed, further to its receptors on digestive tract, MSG stimulated enzymatic activities at the brush border and pancreatic secretions on duodenum which lead to a better digestion and assimilation of nutrients (Jinap and Hajeb, 2010). It also regulated the metabolism (Reeds *et al*., 1997) and reduced the energy loss which was used in synthesis of macromolecules (Garlick, 2005). The improvement in FCR could also be explained by the increase of LBW of chicken fed on diet supplemented with 2 mg MSG/kg. This result contradicted the findings of Gbore *et al.* (2016) who reported a significant increase of FCR in rabbits fed with 2 and 4 mg MSG/kg body weight. This difference could be explained by the high dose of MSG used by different researcher and also the mode of administration used.

The study revealed that dietary levels of MSG had no significant ($p>0.05$) effects on carcass characteristics and digestive organs development (Table 3). The result was in agreement with Sajid *et al.* (2015) who recorded no significant effect on carcass yield and relative weight of liver of broilers fed on Livol, (1 ml/2 liter of water), Livotal (1 ml/4 liter of water) and Hepato promotor (1 ml/4 liter of water). The present result also corroborated the findings of An *et al.* (2015) who recorded no significant difference in carcass characteristics of chickens fed on different doses of onion extracts.

Table 3: Effect of dietary MSG levels on carcasses yield (%) and the relative weight of digestive organs

	Control		MSG Inclusion Levels (mg/kg of diet)			
	R0-	**R0+**	**1**	**2**	**4**	***p-value***
Carcass Traits						
Carcass yield (%)	70.97±6.04	72.22±3.54	70.81±1.48	72.20±1.51	72.78±3.64	0.723
Liver (%BW)	1.91±0.22	2.12±0.35	2.33±0.30	2.07±0.47	2.07±0.24	0.128
Heart (%BW)	0.47±0.09	0.46±0.10	0.50±0.04	0.47±0.10	0.47±0.07	0.831
Abdominal fat (%BW)	1.54±0.77	1.12±0.45	1.23±0.69	1.04±0.60	1.38±0.38	0.403
Digestive Organs Traits						
Gizzard (%BW)	1.52±0.20	1.46±0.20	1.46±0.27	1.41±0.17	1.44±0.14	0.829
Pancreas (% BW)	0.21±0.04	0.23±0.04	0.25±0.05	0.30±0.18	0.24±0.04	0.336
Intestine weight (g)	97.67±13.60	94.89±9.40	88.80±20.83	101.90±17.01	103.22±21.97	0.374
Intestine length(cm)	232.44±27.87	217.67±30.87	215.70±24.91	223.80±47.91	222.00±28.31	0.837
Intestine density(g/cm)	0.42±0.03	0.44±0.03	0.41±0.06	0.47±0.12	0.46±0.04	0.244

R0- = negative control ration. $R0^+$: $R0^-$ + 1g/kg Doxycyclin®; p= probability

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At starter phase, 1 mg and 2 mg of MSG/kg significantly increased lactic acid bacteria counts compared to *Escherichia coli* and *salmonella* (Table 4). The development of lactobacilli leads to a good health of the digestive tract of chickens resulting in good digestion and absorption of nutrients with a positive impact on growth performances. The present result was in agreement with Rahimian *et al.* (2016) who reported a significant increased in lactobacilli with the inclusion of black pepper and protexine in broilers diets. At the finisher phase, 4 mg of MSG/kg induced a significantly higher bacterial count irrespective to the bacterial species. This result suggested that dietary inclusion of MSG promoted the multiplication of bacteria and balance the intestinal flora.

Table 4: Effects of dietary MSG levels on intestinal microbial load of broiler chickens

Bacterial Count	Control		MSG Inclusion Levels (mg/kg of diet)			*p-value*
Log_{10} (UFC)	**R0-**	**R0+**	**1**	**2**	**4**	
Starter phase						
Lactic acid bacteria	9.58±0.25^{ab}	9.33±0.21^{b}	9.84±0.29^{a}	9.84±0.29^{a}	9.42±0.15^{b}	0.027
Escherichia coli	10.14±0.40	10.00±0.12	10.34±0.25	10.52±0.13	10.11±0.42	0.152
Salmonella	10.49±0.29	10.45±0.34	10.43±0.25	9.93±0.88	10.47±0.09	0.405
Finisher phase						
Lactobacilles	9.79±0.16^{d}	10.36±0.39^{cd}	10.16±0.12^{c}	11.22±0.12^{b}	11.63±0.06^{a}	0
Escherichia coli	9.56±0.25^{d}	9.98±0.34^{c}	9.96±0.19^{c}	10.98±0.22^{b}	11.46±0.12^{a}	0
Salmonelles	7.26±0.36^{c}	7.51±0.36^{bc}	8.35±0.12^{a}	7.73±0.21^{b}	8.62±0.12^{a}	0

a, b, c, d: on the same line values affected with different letter differ significantly ($p<0.05$). R0-: negative control ration. $R0^{+}$: $R0^{-}$ + 1g/kg Doxycyclin®; p= probability

Supplementing broilers diet with 1 mg and 4 mg of MSG/kg significantly ($p<0.05$) increased serum content in protein and globulin, and decrease albumin and albumin/globulin ratio compared to all other treatments (Table 5). This result was in agreement with the findings of Obochi *et al.* (2009) who reported a significant increase in serum content in protein of rats fed by 100 mg MSG/kg body weight. It also agrees with the result of Gbore *et al.* (2016) who reported a decrease in serum albumin content with increasing levels of MSG in rabbit. The increase in serum protein content could be attributed to the activation by MSG of transcriptional promoter and enhancer elements used for the control of gene expression, which promoted the ability of RNA polymerase to recognize the nucleotide at the initiation stage, thereby increased protein synthesis (Bernard *et al*., 2002). The high serum content in proteins recorded in the present study can also be attributed to the flavor enhancement of the diet, better FI and better absorption and utilization of digested proteins. The result contradicted the findings of Okediran *et al.* (2014) who reported a decrease in serum protein content in rats fed on diets supplemented with MSG.

Inclusion of 2 mg and 4 mg of MSG in the diet significantly ($p<0.05$) increased serum content in triglycerides (Table 5). This result supported the findings of Egbuonu and Onyinye (2011) who reported a

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significant increase in serum triglyceride in rats fed with 15 mg of MSG in drinking water. The increased in serum triglycerides could indicate apparent breakdown in triglycerides metabolism that probably resulted in mobilization of free fatty acids (Bopanna *et al.*, 1997) as the regulation of triglycerides is driven by the availability of free fatty acids (Schummer *et al.*, 2008). An enhanced lipolysis could, as a consequence, enhance the rapid biosynthesis of plasma triglyceride that might overwhelm the functional ability of Very Low Density Lipoproteins (VLDL) to transport the accumulating triglycerides back to the adipose tissue, leading to the increased serum triglyceride concentration observed in the present study.

Table 5: Effects of dietary MSG levels on biochemical parameters of broiler chickens

Biochemical Parameters	Control		MSG Inclusion Levels (mg/kg of diet)			*p-value*
	R0-	R0+	1	2	4	
Total protein (g/dl)	2.04±0.25^{b}	1.75±0.35^{b}	2.48±0.32^{a}	2.07±0 .20^{b}	2.57±0.36^{a}	0.002
Albumin (g/dl)	1.65±0.32^{a}	1.32±0.18^{b}	1.04±0.16^{c}	1.45±0.28^{ab}	1.03±0.16^{c}	0
Globulin (g/dl)	1.61±0.26^{b}	1.32±0.26^{b}	2.30±0.32^{a}	1.67±0.31^{b}	2.38±0.34^{a}	0
Albumin/Globulin	1.16±0.27^{a}	1.04±0.20^{a}	0.54±0.12^{bc}	0.71±0.13^{b}	0.47±0.07^{c}	0
Triglyceride (mg/dl)	45.89±8.43^{a}	32.79±4.69^{b}	33.71±8.56^{b}	56.46±11.75^{a}	55.40±10.46^{a}	0
Total Cholesterol (mg/dl)	60.45±21.72^{b}	82.68±0.53^{a}	38.53±7.19^{c}	85.85±10.39^{a}	80.09±6.99^{a}	0
HDL-Cholesterol (mg/dl)	39.84±7.40^{b}	49.50±4.27^{a}	40.56±7.32^{b}	46.26±8.70^{ab}	49.82±6.98^{a}	0.053
LDL-Cholesterol (mg/dl)	48.87±5.79^{a}	46.79±2.29^{a}	13.86±3.23^{b}	22.50±5.34^{b}	57.37±12.90^{a}	0
Creatinine (mg/dl)	0.50±0.14	0.43±0.08	0.54±0 .19	0.46±0.08	0.55±0.52	0.943
Urée (mg/dl)	38.06±6.47^{ab}	29.97±2.65^{b}	47.55±17.54^{a}	24.10±5.43^{b}	34.56±11.68^{ab}	0.043
AST (IU/l)	143.94±34.87	129.50±17.13	129.32±27.19	175.87±32.34	133.87±14.44	0.124
ALT (IU/l)	38.35±16.70^{b}	35.43±2.31^{bc}	21.87±5.73^{bc}	64.16±11.75^{a}	17.50±8.48^{c}	0.001

a, b, c: on the same line , values affected with different letter differ significantly (p<0.05); R0-: negative control ration. R0^{+}: R0^{-} + 1g/kg Doxycyclin®; p= probability

Dietary inclusion of 2 mg and 4 mg of MSG induced an increase (p<0.05) in total cholesterol for about 29.58 and 24.52% respectively compared to negative control. In addition, HDL and LDL-cholesterol content increased (p<0.05) linearly with increasing doses of MSG (table 5). This finding corroborated the results of Okediran *et al.* (2014) who also reported a significant increase in serum content in total cholesterol and LDL-cholesterol in male rats fed 0.5g and 1g MSG per day. The increase in cholesterol levels in the present study was higher than the 7.69% reported by Egbuonu and Onyinye (2011) in adult rats treated with 15 mg of MSG/kg body weight. The increase in total cholesterol and LDL-cholesterol could be explained by the ability of MSG to increase the activities of 3-hydroxyl-3-methylglutaryl coenzyme A (HMG CoA) reductase, the rate limiting enzyme in cholesterol biosynthesis resulting in an increasing the synthesis of cholesterol. Mariyamma *et al.* (2009) reported hyperlipidaemia with significantly elevated levels of serum triglycerides and cholesterol in MSG treated rats and suggested that a shift in glucose metabolism towards lipogenesis might explain the hyperlipidaemia recorded.

Serum content in urea was significantly (p<0.05) higher with 1 mg of MSG (Table 5). The present result supported the findings of Khadiga *et al.* (2009) who reported a significant increased of urea in broiler

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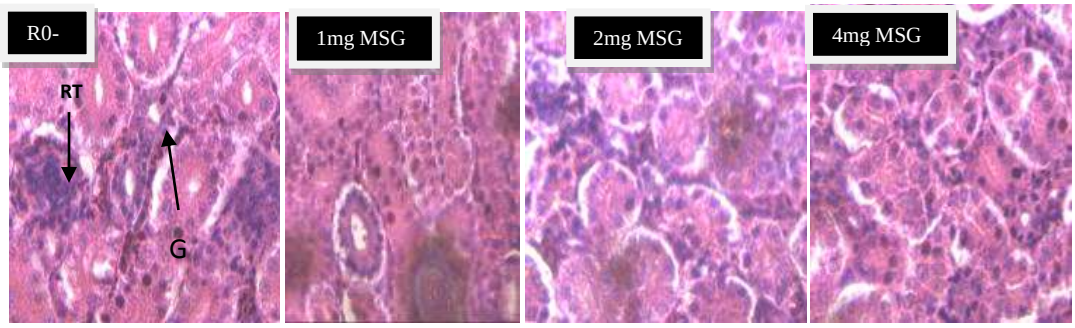
chickens supplemented with 0.5 and 1% MSG. Inuwa *et al.* (2011) also reported an increase in serum concentration in urea in rats fed with 200, 300 and 400 mg MSG/kg body weight. The increase in urea level could indicate an impaired of the kidney function. However, the exploration of histological sections of the kidneys of chickens fed on MSG revealed no mark of injury (Fig. 1). This suggested that the increasing content in serum urea did not reach the critical level which could damage the kidney. This result contradicted the findings of Sharma *et al.* (2013) who observed cases of lithiasic kidneys (hydronephrosis) and urinary tract obstruction in rats with 2 mg MSG/kg of live body.



RT: Renal tubule; G: Glomerular

Fig. 1: Histological structure of the kidney of broiler chikens as affected by MSG (40X)

Feeding chickens with diet supplemented with 2 mg of MSG/kg significantly increased ($p<0.05$) serum content in ALT (Table 5). This result corroborated the findings of Tawik and Al-Badr (2012) who recorded a significant increase in serum ALT in rats fed with 0.6 and 1.6 mg of MSG/g body weight. Okediran *et al.* (2014) also recorded a significant increase in serum ALT on rats fed with 1 g of MSG per day. Similarly, Gbore *et al.* (2016) reported a significant increase in ALT after administration of 2 mg and 4 mg of MSG/kg body weight to rabbits. The increase in serum content in ALT could suggest disturbances in metabolism affecting the liver function. Therefore, the increase in ALT activity might indicate the liver damage. According to Tawfik and Al-Badr (2012), MSG could dissociate easily to release free glutamate and ammonium ion that could be toxic unless detoxified in the liver via the reactions of the urea cycle. Thus, the possible NH4+ overload that may occur as a result of an increased level of glutamate following MSG intake could damage the liver, resulting in enzyme leakage that might lead to observed elevation in their activities. The enzymes are released into the circulating blood only after damage to liver structural integrity (Janbaz and Gilani, 2000). However, the examination of the histological structure of the liver revealed no damage suggesting that ALT content increased without reaching the critical level indicating the hepatic cells damages (Fig. 2).

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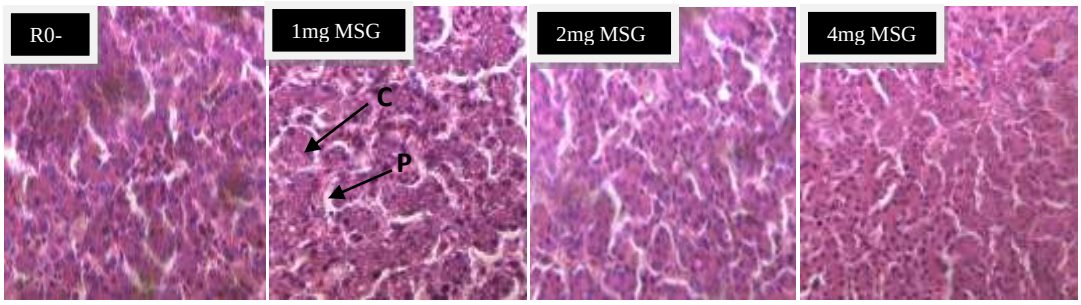

C=Conjonctive tissues , P= Portal spaces

Fig. 2: Histological structure of the liver of broiler chikens as affected by MSG (40X)

This study revealed that feeding broilers with graded levels of MSG did not have any significant ($p>0.05$) effect on blood parameters (Table 6). This finding was in agreement with the results of Gbore *et al.* (2016) for all other blood parameters except white blood cells count, which significantly increased after oral administration of 1 to 4 mg MSG/kg body weight of rabbit. This result suggested that the administration of high dose of MSG to an animal could impaired the immune system and exposed this animal to infection

Table 6: Effects of dietary levels of MSG on hematological parameters of boilers chickens

Parameters	Control		MSG Inclusion Levels (mg/kg of diet)			p-value
	R0-	R0+	1	2	4	
WBC (10^3/µl)	86.00±4.02	81.50±3.54	84.80±5.95	84.87±5.32	85.30±4.58	0.526
RBC (10^6/µl)	2.32±0.26	2.26±0.44	2.11±0.19	2.49±0.14	2.18±0.49	0.402
Hb (g /dl)	13.62±1.16	13.25±2 .27	12.16±1.36	14.32±0.70	12.70±2.88	0.382
HCT (%)	32.52±3.20	31.92±5.52	29.22±3.80	34.63±1.96	30.60±7.33	0.419
MPV (fL)	141.07±8.98	142.25±5.25	138.66±10.23	139.07±2.91	140.38±2.76	0.888
MCH (pg)	59.15±6.30	58.98±3.25	57.62±2.24	57.42±1.24	58.20±1.33	0.878
PLT (10^3/µl)	149.67±78 .05	120.33±25.19	117.20±26.69	138.83±26.69	144.00±41.41	0.588

R0- = negative control ration. $R0^+$: $R0^-$ + 1g/kg Doxycyclin®; P= probability. WBC = White blood cell; RBC = red blood cell; Hb=Hemoglobin; HCT=Hematocrit; MCH=Mean corpuscular hemoglobin; PLT=Platelets; MPV: Mean platelet volume.

Conclusion

The results presented in the present study revealed that feeding broiler chickens with MSG improve growth performance with no detrimental effect on the histological structure of the liver and kidney, and hemato-biochemical parameters. Considering the growing restrictions of antibiotics growth promoters, 2 mg of MSG/kg can be used as feed additive to mitigate the public concern about bacteria resistance issues as well as antibiotics residues in broiler chicken's meat.

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