EFFECTS OF POWDERED MONOSODIUM GLUTAMATE (MGS) ON GROWTH PERFORMANCE, FEED DIGESTIBILITY, HAEMATOLOGY AND CARCASS CHARACTERISTICS OF WEANER RABBITS IN NORTHERN GHANA

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ABSTRACT

The study was carried out to evaluate the effects of dietary monosodium glutamate (MSG) on feed digestibility, haematological parameters and carcass characteristics of weaner rabbits. Sixteen (16) New Zealand White rabbits with an average initial weight of 612.5±9.1 g were randomly assigned to 4 treatment diets in a completely randomized design with 4 replicates in each group. The control diet (T0) contained 0 g of MSG/kg of feed whilst the treatment diets, T1, T2 and T3 contained 0.2 g, 0.4 g and 0.6 g of MSG/kg of feed respectively. The feeding trial lasted for 46 days, feed intake and apparent nutrient digestibility were not affected by the MSG. There were no significant differences (p>0.05) among the treatment diets for weight gain, average daily weight gain and final weight gain. The final weight gain for the control diet was 999 g whilst MSG included diets ranging from 982 g to 1023 g. The addition of MSG to the diets did not increase feed intake, and had no negative effect on haematological parameters, weight gain and carcass characteristics.

Keywords: *Monosodium glutamate, Haematology, Weight gain, Rabbit, Carcass characteristics*

INTRODUCTION

Protein deficiency is a serious problem in developing countries including Ghana. Animal protein is the only source of protein that contains all the essential amino acids required by the human body (MOH, 2010) and so can help reduce protein deficiency. Ajala and Balogun (2004) indicated that rabbit production is the best way of solving the problem of protein deficiency.

Osei *et al.* (2012) indicated that, rabbit, a non-traditional animal is one of the recommended animals for producing high quality protein that could contribute greatly towards meeting human protein requirement in Ghana. The meat of rabbit can be consumed by small family size with no meat storage facilities required. Rabbit can be a suitable candidate for reducing protein malnutrition and poverty among rural households.

Glutamate which is an amino acid has multiple roles in cell metabolism and physiology (Blachier *et al*., 2009). According to Manal and Al-Badr (2012), monosodium glutamate (MSG) is the sodium salt of glutamic acid and the main component of many proteins. It has been used in human diets, for many years, as flavour enhancer to promote consumption rates of food (Parshad and Natt, 2007). Monosodium glutamate improves the palatability of foods thereby enhancing intake which promotes weight gain (Egbounu *et al*., 2010).

A study by Cisa *et al.* (2019) indicated that supplementing 2 mg of MSG/kg as feed additive to broiler chickens improves growth performance. Gbore *et al*. (2016) also reported an improve-

ment in feed intake in rabbits fed with 1 mg, 2 mg and 4 mg of MSG/kg body weight. Gbore *et al*. (2016) also reported a significant improvement in the growth performance of rabbits supplemented with 4 mg MSG/kg of body weight.

Northern Ghana is one of the warmest regions in Ghana. The climate is very warm with an annual average of 34°C and is warm or hot yearlong (World data, 2019). High temperatures, above 30°C, have a significant impact on feed intake, which can drop to 60% in rabbit production (Feed and Nutrition, 2016).

Information regarding the effects of glutamate in the diets of rabbits within the savanna agro-ecological zone is limited. This study was therefore carried out to evaluate the effect of dietary monosodium glutamate on growth performance, feed digestibility, carcass characteristics and blood profile of rabbits.

MATERIALS AND METHOD

Location of experiment

The feeding trial was conducted at the poultry unit of Nyankpala Campus of the University for Development Studies (UDS), Tamale. Nyankpala lies around 18 km west of Tamale in the Tolon District. It is situated on latitude 9˚25' 41" N and longitude 0˚58' 42" W at an elevation of 183 m above sea level (SARI, 2019). The Guinea Savanna Zone is characterized by unimodal rainfall pattern.

Animals, housing and feeding

Sixteen (16) weaned New Zealand White rabbits with an average initial weight of 624±0.3 g were housed individually in wood and wire mesh cages raised 40 cm above the ground with dimensions of 50 x 60 cm. Prior to the commencement of the experiment, the rabbits were dewormed and adjusted to diets for a week. Feed and water were provided *ad libitum* for 46 days. In a Completely Randomized Design (CRD), the rabbits were assigned to four treatments labeled T0, T1, T2 and T3 containing 0 g MSG/kg of feed, 0.2 g MSG/ kg of feed, 0.4 g MSG/kg of feed and 0.6 g MSG/kg of feed respectively. Each treatment had 4 replicates. The experiment was conducted in compliance with regulations for animal experiments of UDS and was closely supervised by a veterinarian.

Experimental diet

Brewer's spent grains

Brewer's spent grain (BSG) is a by-product from "pito" which is a local beverage prepared from cereal grains such as millet or guinea corn. The BSG was procured in their dried state from the pito brewers from Bolgatanga.

Rice bran

The rice brans are by-products obtained from the processes of milling rice to obtain the rice grains. This was bought from rice millers located within Nyankpala. They were already in their dried and good state and did not need further processing.

Table 1: Composition of experimental diets containing varying levels of MSG

Ingredients (g/kg)	MSG inclusion levels (g/kg of feed)			
	T0 (0)	T1 (0.2)	T2 (0.4)	T3 (0.6)
Rice bran	350	350	350	350
Wheat bran	250	250	250	250
Brewer's spent grains	190	190	190	190
Pigeon pea waste	200	200	200	200
Di-calcium phosphate	5	5	5	5
Salt	2.5	2.5	2.5	2.5
Vitamin premix	2.5	2.5	2.5	2.5
Total	1000	1000	1000	1000

Premix composition (per kilogram of diet): vitamin A, 12,500 IU; Vitamin D3, 2500 IU; vitamin E, 50.00 mg; vitaminK3, 2.50 mg; vitamin B1, 3.00 mg; vitamin B2, 6.00 mg; vitamin B6, 6.00 mg; niacin, 400mg; calcium pantothenate, 10mg; biotin, 0.8 mg; vitamin B12, 0.25 mg; folic acid,1.00mg; chlorine chloride, 300mg; manganese, 100mg; iron, 50 mg; zinc, 45 mg; copper, 2.00 mg; iodine, 1.55 mg; cobalt, 0.25 mg; selenium, 0.10 mg; antioxidant, 200 mg.

Wheat bran
The wheat bran was bought from poultry feed dealers in Tamale.

Pigeon pea waste
The pigeon pea waste is a by-product obtained from the processing of the pigeon pea to separate the seeds from the pods. It comprised approximately 50% leaves and 50% pods (husks). The pigeon pea waste was obtained in the dried state and it was further milled to break them into smaller particles to enhance the formulation of the diets.

Feed intake, digestibility and Growth
Daily feed samples were taken from each treatment and stored in a freezer at 4˚C until the end of the experiment. In the end, the preserved samples from each treatment were bulked together and sub-sampled taken for the determination of dry matter. The percentage dry matter was calculated and multiplied by the total feed consumed by each rabbit to get the dry matter intake. The initial weight (W1) g of each animal was recorded using an electronic scale (Kern, PCB-3500-2, Balingen, Germany). After that, the weight was recorded every week. Weight gain was determined by subtracting the initial weight from final weight (W2-W1) g.

The faecal samples collected were weighed, recorded and stored in a refrigerator until the end of the experiment. The faecal samples were bulked together based on each treatment replicate and subsampled for drying in the oven at 60˚C for 48 hrs. The dry matter percentage was computed, and this was used to determine the total dry matter digestibility for each of the treatments.

Proximate analysis
The experimental diets and faecal samples were analyzed for dry matter (DM), Ash, Ether extract (EE) and Crude protein (CP) using the procedure of AOAC (2000) whiles Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were also analyzed as indicated by Van Soest *et al.* (1991).

Blood sampling and analysis
Blood samples were taken from all rabbits using a 5 ml syringe and needle through the marginal ear vein into labeled sample bottles which contained ethylene diamine tetra acetic acidic (EDTA) (Radostitis *et al.,* 1994). Packed cell volume, red blood cell, white blood, and hemoglobin concentrations were determined utilizing the Wintrobes Microhaematocrit, improved Neubauer haemocytometer and Cyanomethaemoglobin methods respectively (Coles, 1986; Baker and Silverton, 1990). The mean corpuscular haemoglobin (MCH) levels were also determined.

Carcass quality analysis
The weight of the rabbits was recorded prior to slaughter at the meat Unit of the University for Development Studies. Slaughtering was done by severing the carotid artery and jugular vein of the rabbit. The dressing percentage dressed hot carcass weight and cold body carcass weight were determined as described by Schivera, (2011), Wilson, (2019) and Schoenian, (2009) respectively. All euthanasia was done at the meat unit of the university. The cervical dislocation was done to render the animals unconscious and then exsanguinated.

Statistical analysis
Data generated were subjected to one-way analysis of variance (ANOVA) using Genstat 18.2. The Shapiro-wilk test was used to assess the normal distribution of the data before the analysis. Significant differences between treatment means were separated using Tukey's honestly significant difference (Tukey's HSD) at 5%.

RESULTS
The results of nutrient analysis of the experimental diets are presented in Table 2. The DM

Table 2: Dry matter, ash and chemical composition of the experimental diets (g/kgDM)

Parameters	Treatments (MSG g/kg feed)			
	T0(0)	T1(0.2)	T2(0.4)	T3(0.6)
DM	955	953	948	950
OM	763	735	765	762
CP	152.9	162.1	162.9	163.8
EE	47.4	42.7	46.0	42.4
Ash	237	265	236	238
NDF	504	576	525	511
ADF	364	389	333	342

MSG=Monosodium glutamate, DM=Dry matter, OM=Organic matter, CP=Crude protein, EE=Ether extract, NDF=Neutral detergent fibre, ADF=Acid detergent fibre

Table 3: Effect of MSG on mean feed intake and average growth performance of rabbit (g)

Parameters	Treatments (MSG-g/kg feed)					
	T0(0)	**T1(0.2)**	**T2(0.4)**	**T3(0.6)**	**SED**	**P-value**
TDMI	2945.94	3099.39	3066.35	3113.15	264.58	0.879
ADMI	64.04	67.38	66.66	67.68	5.752	0.879
IBW	624.00	623.75	624.25	624.50	0.423	0.226
FW	999	1010	1023	982	91.9	0.971
WG	375.00	386.25	398.75	357.50	85.03	0.964
ADWG	8.15	8.40	8.67	7.77	1.848	0.964

TDMI=Total dry matter intake, ADMI=Average daily dry matter intake, IBW= Initial body weight, FW=Final weight, WG=Weight gain, ADWG=Average daily weight gain

Table 4: Coefficients of apparent digestibility of the proximate constituents in diets (g/kg)

Parameters	Treatments (MSG-g/kg feed)					
	T0(0)	T1(0.2)	T2(0.4)	T3(0.6)	Sed	P-value
DM	670	650	620	630	0.066	0.879
OM	600	570	550	560	0.079	0.880
CP	565	629	618	603	0.052	0.496
ADF	590	480	430	570	0.084	0.149
NDF	290	400	250	220	0.134	0.462
EE	330	250	320	280	0.061	0.543

MSG=Monosodium glutamate, DM=Dry matter, OM=Organic matter, CP=Crude protein, EE=Ether extract, NDF=Neutral detergent fibre, ADF=Acid detergent fibre

content was similar among diets. From Table 2, the CP of the experimental diets increased as the MSG level increased in the diet. The CP content in this study ranged from 15.29-16.38% with T0 (0 g of MSG/kg) having a slightly lower CP content of 152.9 g/kg compared to T3 (0.6 g MSG/kg) which had the highest value of 163.8 g/kg.

All parameters measured for feed digestibility (Table 4) did not differ ($p>0.05$) in this study. Crude protein digestibility increased by about 10% when MSG was included at 2g/kg diet. At the same inclusion rate, DM digestibility and OM decreased by about 2.9 and 5% respectively.

There was no significant difference ($p>0.05$) in total dry matter intake, average dry matter intake, final weight gain, weight gain and average daily weight gain (Table 3).

The results of the effect of MSG on blood profile of rabbits are presented in Table 5. In this study, the inclusion levels of MSG at different levels did not cause a difference ($P>0.05$) in the haematology of rabbits.

There was no significant difference ($p>0.05$) in the carcass characteristics (Table 6) measured in this study. Live body weight ranged from 920-1060 g whiles dressing percentage was 40.70-46.20%.

DISCUSSION

The increase in CP of diets with MSG is an indication that monosodium glutamate added to the nitrogen content of the diets. According to Manal and Al-Badr (2012), MSG is the sodium salt of glutamic acid and the main component of many proteins. The National Research Council (NRC)

Table 5: Effect of MSG on carcass characteristics and haematological profile of rabbits

Parameters	Treatments (MSG-g/kg feed)				SED	p-value	Reference range: Moore *et al.* (2015)
	T0(0g)	T1(0.2g)	T2(0.4g)	T3(0.6g)			
HGB (g/dL)	9.80	9.03	10.62	9.25	1.078	0.358	10.7-13.9
MCH (Pg)	18.70	19.85	19.40	18.95	1.267	0.756	19.5-22.7
MCHC (g/dL)	26.57	28.32	27.32	26.80	1.234	0.426	24.2-32.6
MCV (FL)	70.60	70.17	71.22	70.75	3.089	0.980	66.2-80.3
RBC (10^{12}/L)	5.22	4.63	5.47	4.87	0.713	0.536	5.15-6.48
PCV (%)	36.90	32.20	38.90	39.40	4.83	0.360	38.1-44.1
PLT (10^{9}/L)	231	152	314	182	90.3	0.231	-
WBC (10^{9}/L)	3.06	4.06	3.22	3.30	1.693	0.900	4.1-9.79
EOS (%)	0.80	0.44	0.54	0.42	0.2785	0.484	0.2-4
BASO (%)	0.44	0.28	0.67	1.24	0.369	0.130	0.1-4.5
NEU (%)	45.70	47.00	47.10	44.20	14.69	0.997	18.8-46.4
MON (%)	5.06	7.08	6.07	7.70	1.825	0.508	0-13.1
LYM (%)	48.00	45.20	45.80	46.40	14.79	0.997	44.6.77.8

HGB=Hemoglobin, PCV=Packed cell volume, RBC=Red blood cell, WBC=White blood cell, EOS=Eosinophls, BASO=Basophils, NEU=Neutrophils, MON=Monocyte, LYM=Lymphocyte

Table 6: Effect of MSG on carcass characteristics of rabbit

Parameters	Treatments (MSG-g/kg feed)				SED	P-value
	T0(0 g)	T1(0.2 g)	T2(0.4 g)	T3(0.6 g)		
Live Body Weight(g)	920	1008	990	1060	197.2	0.910
Dressing (%)	40.70	45.80	46.20	42.10	4.37	0.556
Hot carcass weight(g)	376(40.9)	469(46.5)	458(46.3)	452(42.6)	126.7	0.874
Cool carcass weight(g)	374(40.7)	466(46.2)	455(46.0)	450(42.5)	125.9	0.879
Shoulder Weight(g)	72(7.8)	86(8.4)	84(8.5)	84(7.9)	19.02	0.895
Thigh Weight(g)	114(12.4)	148(14.7)	143(14.4)	141(13.3)	43.4	0.856
Empty G.I.T(g)	111(12.1)	113(11.2)	103(10.4)	120(11.3)	21.46	0.891
Full G. I.T(g)	286(31.1)	268(26.6)	280(28.3)	325(30.7)	50.2	0.717
Lung Weight(g)	6(0.6)	5(0.5)	5(0.5)	7(0.6)	1.803	0.820
Liver Weight(g)	24(2.6)	33(3.3)	28(2.8)	28(2.6)	3.57	0.211
Heart Weight (g)	3(0.3)	3(0.3)	4(0.4)	4(0.4)	1.061	0.757
Kidney weight(g)	7(0.8)	7(0.6)	7(0.7)	6(0.6)	1.620	0.908
Head Weight(g)	100(10.8)	112(11.1)	102(10)	113(10.6)	16.03	0.784
Feet Weight(g)	73(7.9)	45(4.4)	44(4.4)	44(4.1)	8.05	0.771

GIT=Gastrointestinal tract, Figures in bracket are expressed as percentage of the live body weight

(1977) and Obinne and Okorie (2008) recommended 16% CP for the optimum growth of rabbits, but Akande (2015) reported 15-16% CP for the maximum growth of tropical rabbits. The CP concentration in the current study was within the range of 15-16%.

The values recorded for NDF in the present study was higher than the 30% recommended to minimize the accumulation of digesta in the caecum (De Blas and Mateos, 1998).

The EE reported in this study was similar to values of 7.5-72 g/kg observed by Ansah *et al*. (2014) and it has been reported by Maertens *et al*. (1986) that higher EE has the tendency to reduce dry matter feed intake and may decrease effective ether digestibility because of its effect on digestive efficiency. When rabbits are fed on higher fat feed, there is decrease in cellulolytic and pectinolytic activity in the caecum and caecotrophes of rabbits (Falcão-e-Cunha *et al*., 2004).

The addition of MSG to the diet did not significantly increase feed intake as reported by Khadiga *et al*. (2009) that an inclusion level of 1% MSG significantly increased feed intake in broiler chicken. According to Jinap and Hajeb (2010), MSG stimulates the brain cells involved in appetite. The lack of significant difference ($p>0.05$) in growth performance in this experiment is not consistent with many researchers who reported significant increase in growth performances of animals fed MSG based diets at various levels. Gbore *et al.* (2016) indicated significant difference in growth performance in rabbits fed with 4 mg MSG/kg of body weight. Rats treated with 15 mg and 30 mg MSG/body weight had an increase in live body weight (Falalieieva *et al*., 2010). Cisa *et al.* (2019) reported an increase in live body weight and weight gain in chickens fed with diet supplemented with 2 mg MSG/kg of feed. Dietary supplementation with up to 4% MSG is considered safe and enhances growth performance in young piglets (Rezaei *et al*., 2012). The present study also differs from that of Kondoh and Torri (2008) who reported smaller body performance of rats treated with monosodium glutamate. These disparities in growth performances could be attributed to species, breed and environment of the study area.

The dry matter digestibility reported in this study (Table 4) is similar to that of Gasco *et al*. (2019) who fed rabbits with insect fat. Gasco *et al*. (2019) recorded digestibility coefficients of 606-616 g/kgDM. The indifferences among diets in dry matter digestibility is an indication that the rabbits did not respond positively to the levels of MSG added to the diet in the present study. It has been reported that animal differences and length of consumption of MSG have effect on animal responses (Okoye *et al*., 2016). The indifferences observed in carcass evaluation is in agreement with Cisa *et al*. (2019) who recorded no significant effect on carcass characteristics in broiler chickens fed at various graded levels with MSG.

The dressing percentage in this study fell below the recommended range of 55-61% of rabbits reported by Ouhayoun (1998) and Dalle Zotte and Ouhayoun (1998). The dressing percentage was in the range of 40.7-46.2% (Table 6). This could have been attributed to the age of rabbits at slaughtering and the different diets used by researchers.

Haematological parameters recorded in this study were consistent with the report of Gbore *et al*. (2016) and More *et al*. (2015). However, the white blood cells count in the study of Gbore *et al.* (2016) increased significantly after rabbits were treated with 1 to 4 mg MSG/kg body weight. The range of values for hemoglobin (HGB) in this study falls within the range of HGB (9.3-19.3g/dl) reported by Mitruker and Rawsnley (1977); Jain (1986) and Zimmerman *et al.* (2010). This indicates that all experimental diets had the same influence on the haematology of rabbits and inclusion levels were good for the healthy growth of rabbits. The packed cell volume (PCV) values of this study (32.20-39.40%) were acceptable compared with the normal range (30-35%) (More *et al*. 2015; Mitruka and Rawsnley 1977). The result recorded for red blood cell (RBC) was within the range of values reported by Mitruka and Rawsnley (1977) and Fudge (1999) who also recorded a similar range of values 4.00-8.60 (x 10^6/mm^3) for RBC. This is an indication that the experimental rabbits did not show any symptoms of anemia. The white blood cell (WBC) and differentials reported in this study were within the range as reported by

Hillyer (1994) for healthy young rabbits (Table 5). Burke (1994) also reported that white blood cells count of 5-13 (x 10^9/l) is within the normal range. According to Togun *et al.* (2007), when blood parameters fall within the normal range it means that the diets did not have any adverse effects on blood parameters.

CONCLUSION

The results as shown above indicate monosodium glutamate (MSG) in rabbits' diet did not improve weight gain over the control but had no negative effect on the health of rabbits.

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