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Research Application Summary

Effect of monosodium glutamate (MSG) on growth performance, carcass characteristics and haematology profile of rabbits

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Abstract

The study was carried out to evaluate the effects of dietary monosodium glutamate (MSG) on growth performance, haematological parameters and carcass characteristics of rabbits. The feeding trial lasted for 46 days. A completely randomized design was used and sixteen New Zealand White rabbits with an average initial weight of 612.5±9.1g were randomly assigned to four treatment diets with four replicates in each group. The tested diets were T0 (with no MSG), T1 (0.2g MSG), T2 (0.4g MSG) and T3 (0.6g MSG) per kilogram of feed respectively. Feed intake, feed digestibility, feed convection ratio (FCR), growth performance, haematological parameters and carcass characteristics did not differed not (P>0.05). Monosodium glutamate (MSG) used as feed additive did not improve growth performance and affect the health of the rabbits.

Key words: Feed additative, monosodium glutamate, rabbit

Résumé

L'étude a été réalisée pour évaluer les effets du glutamate monosodique alimentaire (GMS) sur les performances de croissance, les paramètres hématologiques et les caractéristiques de la carcasse des lapins. L'essai d'alimentation a duré 46 jours. Une conception complètement randomisée a été utilisée et seize lapins blancs de Nouvelle-Zélande avec un poids initial moyen de 612,5 ± 9,1 g ont été assignés au hasard à quatre régimes de traitement avec quatre répétitions dans chaque groupe. Les régimes alimentaires testés étaient T0 (sans GMS), T1 (0,2 g de GMS), T2 (0,4 g de GMS) et T3 (0,6 g de GMS) par kilogramme d'aliments respectivement. La consommation alimentaire, la digestibilité des aliments, le rapport de convection alimentaire (RCA), les performances de croissance, les paramètres hématologiques et les caractéristiques de la carcasse ne différaient pas (P>0,05). Le glutamate monosodique (GMS) utilisé comme additif alimentaire n'a pas amélioré les performances de croissance et n'a pas affecté la santé des lapins.

Mots clés : Additif alimentaire, glutamate monosodique, lapin

Introduction

According to the Ghana Ministry of Health (MOH) (2010), protein deficiency is a serious problem in developing countries including Ghana. Lack of protein causes kwashiorkor in young children (under five years) who do not have enough protein added to their diet (MOH, 2010). Animal protein is seen as a source that contains all the essential amino acids required by human body (MOH, 2010) and so can help reduce the protein deficiency. Ajala and Balogun (2004) indicated that rabbit production is the best way of solving the problem of protein deficiency. From the nutritional point of view, rabbit meat has good flavour and is easily digested, with high nutritional and dietetic properties: this meat contains 20–21% of proteins, unsaturated fatty acids (oleic and linoleic; 60% of all fatty acids), potassium, phosphorus, and magnesium. It has low concentrations of fat, cholesterol, and sodium (Simonová *et al.,* 2010).

In Ghana the current per capita meat consumption of 11 kilograms is lower than that Sub-Sahara Africa (13 kilograms) and the world's average of 39 kilograms. Ghanaians are therefore urged to consume more rabbit meat.

Glutamate is an acidic amino acid with multiple roles in cell metabolism and physiology. This nutrient is involved in both synthetic and oxidative pathways in tissues (Blachier *et al.,* 2009). According to Tawfik 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 worldwide for many years in human diets as flavor enhancer to promote consumption rates of a particular foods (Parshad and Natt, 2007). Although MSG could improve the palatability of foods by exerting a positive influence on the appetite centre, it also positively impacts on body weight gain (Egbounu *et al.,* 2010). Studies conducted by Ciza *et al.* (2019) indicated that supplementing 2mg of MSG/kg as feed additive to broiler chickens improve growth performance. Gbore *et al.* (2016) also reported an improvement 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 growth performance of rabbits supplemented with 4 mg MSG/kg of body weight. However, information regarding the effect of glutamate in the diets of rabbits is limited. This study was therefore carried out to evaluate the effect of Monosodium glutamate on the growth performance, feed digestibility, blood profile and carcass characteristic of rabbits.

Materials and Methods

Study area. The experiment was undertaken at the poultry unit at the Nyankpala Campus of the University for Development Studies, Northern Region, Tamale, Ghana. 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 ocean level (SARI, 2020). The territory is inside the Guinea Savanna Zone characterized by a unimodal precipitation system. Downpours start in April, peaking in August-September and closure in October or November. The normal precipitation is 1060 mm annually. Temperatures range from as low as 15˚C in January when the climate is influence by the North Easterly (Harmattan) wind and as high as 42˚C towards to the end of the dry season in March (SARI, 2020).

Housing and management. Sixteen (16) weaned New Zealand White rabbits weighing on average 612.5±9.1g were used. The rabbits were housed in wire mesh cages of 50x60x40cm dimension. The rabbits were dewormed and adjusted to the diet for 7 days. A quantity of 100g of feed was offered to the rabbits daily for 46 days and with water offered ad libitum.

Treatments and experimental design. The Completely Randomized Design (CRD) was used in grouping the rabbits put on the four treatments T0, T1, T2 and T3 containing 0g MSG/kg, 0.2g MSG/ kg, 0.4g MSG/kg and 0.6g MSG/kg feed, respectively. All dietary treatment had four replicates with one rabbit each. The composition of the feed ingredients is shown in Table1.

Table 1. Percentage composition of feed ingredients

Ingredients (kg)	Treatments			
	T0 (0g MSG)	T1 (0.2g MSG)	T2 (0.4g MSG)	T3 (0.6g MSG)
Rice bran	35	35	35	35
Wheat bran	25	25	25	25
BSG	19	19	19	19
Pigeon pea waste	20	20	20	20
DCP	0.5	0.5	0.5	0.5
Salt	0.25	0.25	0.25	0.25
Vitamins premix	0.25	0.25	0.25	0.25
Total	100	100	100	100

Premix composition (per kilogram of diet): vitamin A, 12,500 IU; Vitamin D3, 2500 IU; vitamin E, 50.00mg; vitamin K3, 2.50 mg; vitamin B1, 3.00mg; vitamin B2, 6.00mg; vitamin B6, 6.00mg; niacin, 400mg; calcium pantothenate, 10mg; biotin, 0.8mg; vitamin B12, 0.25mg; folic acid,1.00mg; chlorine chloride, 300mg; manganese, 100mg; iron, 50mg; zinc, 45mg; copper, 2.00mg; iodine, 1.55mg; cobalt, 0.25mg; selenium, 0.10mg; antioxidant, 200mg

Data collection

Live weight gain. The initial weights (W_1) g of the animals were recorded and after every 7days of feeding, the weights (W_2) g of the animals were taken. Weight gain was determined from the difference between the initial and final weight.

Digestibility trials. Faecal outputs were collected daily for five days during five weeks of the experiment. The faecal outputs collected were weighed and recorded. Samples were taken and stored in a refrigerator till the experiment ended. The faecal samples were put together based on each treatment replicate and subsample taken for drying in the oven at the end of the experiment. Duplicates of each sampled were weighed and dried in the oven at 60˚C for 48 hrs. The dry matter percentage was computed and this was used to determine the total digestibility for each of the treatments.

Blood hematology sampling. Blood samples were acquired from every rabbit in the treatment groups utilizing a 5ml plastic needle through the marginal ear vein into well marked sample bottles which contained ethylene diamine tetra-acidic corrosive (EDTA) as anticoagulant (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).

Dressing percentage. This was determined by taking the dressed hot body carcass weight and dividing it by the final live-weight of the animal and multiplied by 100.

Hot body carcass weight. The dressed hot body carcass weight was taken about 10-30 min after the animals were slaughtered. The dressed hot body carcass excluded blood, skin, distal pieces of the tail, hind and fore legs, gastrointestinal and urogenital parcels.

Cold body carcass weight. Cold body carcass weight was taken when carcass was chilled for 24 hrs in a ventilated cold room maintained at 4˚C.

Chemical analysis. Dry matter, ash, ether extract and crude protein were determined by the methods of AOAC (2000). The Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were also analyzed as described by Van Soest *et al.* (1991).

Statistical analysis. Growth performance, feed intake, carcass, hematology and nutrient digestibility data were subjected to analysis of variance (ANOVA) using Genstat 18.2th edition. Where significant difference occurred means were separated using Tukeys at 5%.

Results and Discussions

Proximate composition of the treatment diets. The results of the proximate analysis of the treatment diets are presented in Table 2. The dry matter content in this study was fairly similar among treatment diets. The higher value was observed in the control diet (T0). The crude protein content of the diets ranged from (106-114g/kgDM), which was far lower than the protein requirement of (170-230g/kgDM) of weaned rabbits for growth as indicated by Salma *et al.* (2004). The recommended level of crude protein for optimum growth is 160 g/kgDM (Okorie, 2007). The highest crude protein content was observed in the control diet compared to the MSG inclusive diets. The low content of protein level in the MSG inclusive diets of 0.2 to 0.6g MSG/ kg of feed in this study did not conform to the assertion made by Tawfik and Al- Badr (2012) that monosodium glutamate is the main component of many proteins because it is the sodium salt of glutamic acid.

The ash content ranged from 230-260g/kgDM and this was higher than the value reported by Nadiatu (2013) in sunflower leave meal fed to rabbits. The highest ether extract value was observed in the control diet of 47.4g/kgDM and the lowest in T3 (42.4g/kgDM) which contained the highest inclusive level of MSG. High ether extract makes feed unpalatable and has the tendency to reduce dry matter intake and may reduce the digestibility of ether, because it has effects on digestive efficiency and the activity of microflora in the caecum (Maertens *et al.,* 2004). Treatment 1 (0.2g MSG/kg) of feed recorded the highest value for both the Neutral detergent fibre and Acid detergent fibre compared to other treatments.

Table 2. Proximate composition of experimental diets

Parameters	Treatments			
	T0 (0g MSG)	T1(0.2gMSG)	T2(0.4gMSG)	T3(0.6gMSG)
DM (g/kgDM)	955	953	948	950
OM (g/kgDM)	763	735	765	762
CP (g/kgDM)	114	106	113	112
EE (g/kgDM)	47.4	42.7	46.0	42.4
Ash (g/kgDM)	237	265	236	238
NDF (g/kgDM)	504	576	525	511
ADF (g/kgDM)	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.

Feed digestibility. It was anticipated that the control diet would enhance weight gain, however, this was not reflected in final weight gain as compared to the MSG inclusive diets as growth rates were not significantly different (p>0.05) among animals on the four treatment diets. This is possibly due to the similar levels of protein content among the treatment diets. Protein is used to build new cells and replacing worn out tissues (Ranjhan, 1999).

Table 3. Digestibility of nutrients by rabbits fed on MSG supplemented diets

Parameters (g/kgDM)	Treatments					
	T0(0g MSG)	T1(0.2g MSG)	T2(0.4g MSG)	T3(0.6g MSG)	P. value	SED
DM	670	650	620	630	0.878	0.066
OM	600	570	550	560	0.880	0.079
CP	710	670	670	670	0.825	0.059
ADF	590	480	430	570	0.149	0.084
NDF	290	400	250	220	0.462	0.134
EE	330	250	320	280	0.543	0.061

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

Table 4 shows the effect of MSG on growth, dry matter intake, haematology and carcass characteristics of rabbits. There was improvement in the final weight of rabbits. However, there was no significant difference (p>0.05) in final weight gain, weight gain and average daily gain among treatment means (Table 4).

The highest values of final weight gain, weight change and daily gain was recorded in diet T2 which contained 0.4g MSG/kg of feed and the least value of final growth gain, weight change and daily weight gain recorded in diet T3 which contained the highest inclusive level of 0.6g MSG/ kg of feed. This suggests that dietary inclusive level of 0.4g MSG/kg of feed or below will induce growth performance in rabbit.

This result was contrary to the results of many researchers who reported significant increase in growth performances of animals fed MSG based diets at various levels. For example, Gboire *et al.* (2016) reported significant increase in growth performance in rabbits fed with 4mg MSG/ kg of body weight. The present study did not also support the findings 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 quality of diets used. Dry matter intake (Table 4) recorded did not differ (P=0.879) among treatment and may be due to similar CP level observed in all treatments. There are reports that the inclusion of MSG in diets of animals could be toxic to erythrocytes and can cause deleterious changes in blood and biochemical characteristics (Ashaolu *et al.,* 2011; Meraiyebu *et al.*, 2012). This study revealed that the dietary levels of MSG used did not cause any significant difference (p>0.05) for the haematological parameters considered (Table 4). This result agrees with the report of Gboire *et al.* (2016) that there was no significant change for all other blood parameters except white blood cells count which increased significantly after 1 to 4 mg MSG/kg body weight were given to rabbits orally.

There was no significant difference (p>0.05) across the treatment diets for all the blood parameters

considered in this study. The values ranged from 9.03 to 10.62 with T2 recording the highest value of 10.62 (Table 4). The range of values for HGB in this study fell within the range of HGB values reported by Mitruka and Rawnsley (1977), Jain (1986) and Zimmermen *et al.* (2010). The values of the haemoglobin (HGB) concentration also compared favourably with the values of 9.4-17.4 g/dl indicated by Fudge (1999) and Njidda *et al.* (2006). This suggests that all the treatment diets contained similar dietary nutrients and had the same influence on blood parameters.

The PCV values of the present study also fell within the normal range reported by Mitruka and Rawssley (1977). The similar values obtained for all the treatment groups is an indication of adequate nutrient in all diets tested and thus, the animals may not show any sign of malnutrition (Church *et al.,* 1984). The present result recorded for RBC fell within the range of 3.07-7.50 x 106/mm3 reported by Mitruka and Rawsnley (1977) and Fudge (1999) who also recorded the RBC range of 4.0-8.50 (x 106/mm^3).

The study did not record any anaemia in the experimental animals. According to Togun *et al*. (2007), when blood parameters fall within the normal range of rabbits as indicated by Mitruka and Rawsnley (1977), it means that the diets did not have any adverse effects on blood parameters of the rabbits.

The white blood cell count recorded in this study was in the range of 3.06- 4.06 (Table 4). The WBC did not show any significant differences ($p>0.05$) across the treatment diets. The present result contradicts that of Elyazji *et al.* (2015) who reported that there was significant increase in WBC in rabbits administered with MSG and MSG plus soybean oil. The values obtained in this study were within the range of 5-13 x 103/mm^3 reported by Hillier (1994) for healthy young rabbits. There were no significant differences ($p>0.05$) among all the white blood cell counts: neutrophils, basophils, eosinophils, monocytes and lymphocytes across the treatment diets. This may be an indication that there was no toxin assault or disease implying that WBC did not adjust to fight the toxin assault in the diets, since lymphocytes are known to be among body defense mechanisms that fight against non-self or pathogenic organisms (Sirois, 1995; Muhammed and Oboyede, 2009). The present study revealed that the tested levels had no significant ($p>0.05$) effects on carcass evaluation parameter (Table 4). The present result is in agreement with Ciza Azine *et al.* (2019) who recorded no significant effect on carcass characteristics in broiler chickens fed various graded levels of MSG.

The high crude protein in animals in diet T3 did not influence the dressing percentage. The lack of differences observed in both the carcass and non-carcass characteristics might be due to similar effects on weight gain of the experimental rabbits.

Table 4. Effect of monosodium glutamate (MSG) on growth, dry matter intake, haematology profile and carcass characteristics of rabbits

Parameters	Treatments					
	T0(0g MSG)	T1(0.2g MSG)	T2(0.4g MSG)	T3(0.6g MSG)	P value	SED
FLW(g)	999	1010	1023	982	0.971	91.9
WG (g)	375	386	399	358	0.964	85.03
ADWG (g)	8.15	8.40	8.67	7.77	0.964	1.848
ADMI (g/day)	64.04	67.38	66.66	67.68	0.879	5.752
ND	0	0	0	2	-	-
Hae (g/dL)	9.80	9.03	10.62	9.25	0.358	1.078
PCV (%)	36.90	32.20	38.90	39.40	0.360	4.83
RBC (10˜12/L)	5.22	4.63	5.47	4.87	0.536	0.713
WBC(10˜9/L)	3.06	4.06	3.22	3.30	0.900	1.693
Eos (%)	0.80	0.44	0.54	0.42	0.484	0.2785
Bas (%)	0.44	0.28	0.67	1.24	0.130	0.369
Neu (%)	45.70	47.00	47.10	44.20	0.997	14.69
Mon (%)	5.06	7.08	6.07	7.70	0.508	1.825
Lym (%)	48.00	45.20	45.80	46.40	0.997	14.79
Dressing (%)	40.70	45.80	46.20	42.10	0.566	4.37
HCW(g)	376	469	458	452	0.874	126.7
CCW(g)	374	466	455	450	0.879	125.9

FLW=Final live weight, WG=Weight gain, ADWG=Average daily weight gain, ADMI=Average dry matter intake, ND= Number of death, Hea=Heamatology, PCV=Pack cell volume, RBC=Red blood cell, Eos= Eosinophils, Bas= Basophils, Neu= Neutrophils, Mon=Monocyte, Lym=Lymphocyte.HCW=Hot carcass weight, CCW=Cold carcass weight.

Conclusion

Monosodium glutamate (MSG) incorporated in the diet compared favorably with the control with no negative effects observed in the rabbits.

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