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Growth performance, nutrient digestibility and carcass characteristic of growing rabbits fed diets supplemented with organic and inorganic chromium

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Abstract

Sixty three (63) growing rabbits at twelve weeks old (composite breeds), with a mean weight of 1280+ 58g was used for this experiment, and were assigned to 7 dietary treatments, with 3 replicates of 3 rabbits per replicate. Rabbit weight and feed consumption were recorded weekly for eight weeks to calculate weight gain and feed conversion. The experimental diets was formulated using the following levels of inclusions in brewers dry grains (containing 4.38g/kg of chromium) and chromium chloride, accordingly, as the organic and inorganic sources: 0.0g of chromium for the control, 0.02g/kg of organic and inorganic chromium, 0.04g/kg of organic and inorganic chromium, 0.06g/kg of organic and inorganic chromium, and 0.06g/kg of total chromium. Metabolic trials, carcass evaluation and nutrient digestibility was carried out to determine the effect of adding chromium on the carcass qualities of the rabbits. All Data collected during this study were subjected to analysis of Variance (ANOVA) in a completely randomized design (CRD). There were significant (P>0.05) differences in final body weights, weight gain and feed intake among treatments means, with treatment 4 been significantly (P>0.05) higher than the other treatments, with treatments 3 and 7 having the lowest values. For weight gain, the results recorded in the final weight gain followed a similar trend with treatments 4 and 6 having a significantly (P>0.05) higher values recorded, with treatment 7 recording the lowest value. Treatments 4 and 6 showed better feed conversion ratio with values of 9.57 and 9.81 across the dietary treatments. Treatment 6 recorded significantly higher values for crude fibre, ash (mineral) and ether extract digestibility in all the experimental treatments. The carcass weight value in treatment 6 (642.32g) was significantly (P<0.05) better than the other treatments with treatment 7 showing the least value of 574.63g. The pre slaughter weight, carcass weight and dressing percentage, showed that treatment 6 mean values was better compared to treatment 1, 3, and 4 respectively, This study has demonstrated that although the various levels of chromium inclusion had a substantial impact on the numerous parameters examined, organic chromium inclusion, particularly at concentrations of 0.04g/kg (T4) and 0.06g/kg (T6), had a higher impact.

Keywords – chromium, rabbit, treatment, design, data

Performances de croissance, digestibilité des nutriments et caractéristiques de carcasse de lapins en croissance nourris avec des régimes enrichis en chrome organique et inorganique.

Résumé

Soixante-trois (63) lapins en croissance âgés de douze semaines (races composites), d'un poids moyen de 1280+ 58g, ont été utilisés pour cette expérience et ont été affectés à 7 traitements alimentaires, avec 3 répétitions de 3 lapins par répétition. Le poids et la consommation alimentaire des lapins ont été enregistrés chaque semaine pendant huit semaines afin de calculer le gain de poids et la conversion alimentaire. Les régimes expérimentaux ont été formulés en utilisant les niveaux suivants d'inclusions dans les grains secs de brasserie (contenant 4,38 g/kg de chrome) et le chlorure de chrome, en conséquence, comme sources organiques et inorganiques : 0,0 g de chrome pour le contrôle, 0,02 g/kg de chrome organique et inorganique, 0,04 g/kg de chrome organique et inorganique, 0,06 g/kg de chrome organique et inorganique et 0,06 g/kg de chrome total. Des essais métaboliques, d'évaluation des carcasses et de digestibilité des nutriments ont été réalisés pour déterminer l'effet de l'ajout de chrome sur les qualités des carcasses des lapins. Toutes les données collectées au cours de cette étude ont été soumises à une analyse de variance (ANOVA) dans une conception complètement randomisée (CCR). Il y avait des différences significatives (P > 0,05) dans le poids corporel final, le gain de poids et la consommation alimentaire entre les moyennes des traitements, le traitement 4 étant significativement (P > 0,05) plus élevé que les autres traitements, les traitements 3 et 7 ayant les valeurs les plus faibles. Pour la prise de poids, les résultats enregistrés lors de la prise de poids finale ont suivi une tendance similaire, les traitements 4 et 6 ayant enregistré des valeurs significativement (P>0,05) plus élevées, le traitement 7 enregistrant la valeur la plus faible. Les traitements 4 et 6 ont montré un meilleur taux de conversion alimentaire avec des valeurs de 9,57 et 9,81 pour tous les traitements diététiques. Le traitement 6 a enregistré des valeurs significativement plus élevées pour la digestibilité des fibres brutes, des cendres (minéraux) et des extraits éther dans tous les traitements expérimentaux. La valeur du poids de la carcasse dans le traitement 6 (642,32 g) était significativement (P <0,05) meilleure que celle des autres traitements, le traitement 7 montrant la valeur la plus faible de 574,63 g. Le poids avant abattage, le poids de la carcasse et le pourcentage d'habillage ont montré que les valeurs moyennes du traitement 6 étaient meilleures par rapport aux traitements 1, 3 et 4 respectivement. Cette étude a démontré que bien que les différents niveaux d'inclusion de chrome aient eu un impact substantiel sur de nombreux paramètres examinées, l'inclusion de chrome organique, en particulier à des concentrations de 0,04 g/kg (T4) et 0,06 g/kg (T6), avait un impact plus élevé.

Mots-clés – chrome, lapin, traitement, conception, données

Introduction

Chromium, the 21st most common element in the earth's crust. It can occur in oxidative levels ranging from -2 to +6, however it is generally commonly found in trivalent and hexavalent forms (Amata, 2013). Trivalent chromium (Cr3+) is considered to be a very safe type of chromium since it is present in living things in a more stabilized oxidation state (Lindeman, 1996; Amata, 2013.). It has been revealed that chromium plays crucial roles in the activation of some enzymes and the conservation of nucleic acids and proteins (Anderson, 2000). Overall detrimental effects of stress on cattle have been shown to be reduced by chromium supplements (Sahin et al., 2001; Makanjola and adebiyi, 2012; Hashem and Alsaidi, 2019), because chromium (Cr) intake in feeds is fairly low and several authors have proven its potential integration for ideal growth performance in both animals and humans. There has also been a lot of research interest in this topic in recent years (Mertz, 1993; Lukaski, *et al* 1996; Vincent, 2000; Sahin *et al*, 2001; Racek, 2003; Moeini *et al*., 2011; Rao *et al*., 2012; Rajalekshmi *et al*., 2014, Ebegbulem *et al* 2017). It is important to highlight that chromium (Cr), despite being essential for animal nutrition and treatment, is also regarded as a strong poison. Trivalent chromium (Cr) is a necessary trace mineral for optimal utilization of carbohydrates, lipids, proteins, and nucleic acids in humans and test animals, According to Amata (2013), It is also a part of the structure of a glucose tolerance factor that stimulates the function of insulin. Nevertheless, there seem to be considerable discrepancies in the findings of the research on the addition of supplementary chromium to rabbit diets, and there are no clues as to the sources or suggested inclusion levels. A comparison is required because it has been claimed that organic chromium sources are more readily absorbed and effective than inorganic sources (Piva et al., 2003).

Materials and Methods

Dietary supplements with chromium were used in this experiment. The experimental diets were created using the following levels of inclusions in brewers dry grains (4.38g/kg) and chromium chloride, accordingly, as the organic and inorganic sources: 0 for the control, 0.02g/kg of organic and inorganic chromium, 0.04g/kg of organic and inorganic chromium, 0.06g/kg of organic and inorganic chromium, and 0.06g/kg of total chromium. Sixty three (63) growing rabbits at twelve weeks old (composite breeds), with a mean weight of 1280± 58g were assigned to the 7 dietary treatments, with 3 replicates of 3 rabbits per replicate. Feed and water were freely available. Rabbit weight and feed consumption were recorded weekly to calculate weight gain and feed conversion. This was done for eight (8) weeks. Three rabbits were assigned to each of the experimental diets. Faeces from each rabbit were collected in labelled polyethylene bags and stored. Composition of feed and faecal samples was determined using the techniques outlined by AOAC (2019). Faecal apparent digestibility of CP, CF, EE and ash were determined for each diet. At the end of the metabolic trials, carcass evaluation was carried out to determine the effect of chromium supplementation on the carcass qualities of the rabbits. At the end of the metabolic trials, one rabbit per replicate (three per treatment) was randomly selected, starved of feed overnight and slaughtered by cutting the jugular vein to allow proper bleeding. The slaughtered rabbits were scalded and eviscerated to evaluate their carcasses. All the different cut-up parts were weighed and expressed in percentage of the eviscerated weight (PEW).This was done using one animal per replicate in phase 1 of the experiment. All Data collected during this study were subjected to analysis of Variance (ANOVA) in a Completely Randomized Design (CRD) using GenStat (Release 4.24) statistical package (Genstat, 2014). Differences between means were separated by the Duncan's Multiple Range Test (DMRT).

Results

Results on the performance of growing rabbits fed the experimental diets at the growing (first) phase are presented in Table 2 below. There were significant (P>0.05) differences in final body weights, weight gain and feed intake among treatments means. There was a marginal increase in final body weight from 1540g – 1867g. Treatment 4 was significantly (P>0.05) higher than each of the other treatments, with treatments 3 and 7 having the lowest values. For weight gain, the results recorded in the final weight gain followed a similar trend with treatments 4 and 6 having a significantly (P>0.05) higher values recorded, with treatment 7 recording the lowest value. Daily feed intake results recorded ranged from 93.33g – 110g, Treatments 4 and 6 showed better feed conversion ratio with values of 9.57 and 9.81 across the dietary treatment with treatments 5 and 7 having the lowest values of 22.47 and 22.54 respectively. The incorporation of organic and inorganic chromium in growing rabbits diets at varying levels showed significant (P<0.05) influence on nutrients digestibility among the different treatments as presented in table 4.6,with treatments 4 and 6 recording higher crude protein digestibility compared with treatments 5 and 7 respectively. Across all treatments, treatment 6 recorded significantly higher values for crude fibre, ash (mineral) and ether extract for nutrient digestibility in all the experimental treatments. The carcass evaluation and organ weights results of growing rabbits fed the experimental diets after slaughtering at the twelfth week are shown in Table 3 below. Significant (P<0.05) differences in pre-slaughter weight, carcass weight and dressing percentage values of rabbits were observed across the dietary treatments. The carcass weight value in treatment 6 (642.32g) was significantly (P<0.05) better than the other treatments with treatment 7 showing the least value of 574.63g. The pre slaughter weight, carcass weight and dressing percentage as reported in Table 3 below, showed that treatment 6 mean values was better compared to treatment 1, 3, and 4 respectively, However, data on dressing percentage recorded was not significantly (P>0.05) different across the treatment means, although treatment 4 and 5 recorded the highest and lowest values respectively. The heart, lungs, liver and kidney weights all showed significant (P<0.05) differences among the growing rabbits fed experimental diets. The head, tail, and thigh were significantly (P<0.05) different among the treatment groups, with treatment 3 and 6 recording higher values when compared to the other treatment.

Table1. Compositions of experimental diets (%)

Ingredients	**T1 (0%)**	**T2 (0.02g/kg Org)**	**T3 (0.02g/kg In.org)**	**T4 (0.04g/kg Org.)**	**T5 (0.04g/kg In.org)**	**T6 (0.06g/kg Org)**	**T7 (0.06g/kg In.org)**
Maize	47.00	46.00	47.00	45.00	47.00	43.00	47.00
Wheat offal	15.00	13.40	15.00	12.80	15.00	11.20	15.00
Soya bean meal	20.00	19.00	20.00	18.00	20.00	17.00	20.00
Groundnut cake	10.00	9.00	10.00	8.00	10.00	8.00	10.00
Fish meal	5.00	5.00	5.00	4.00	5.00	4.00	5.00
Bonemeal	2.50	2.50	2.48	2.50	2.46	2.50	2.44
Brewers dried grains	----	4.60	---	9.20	---	13.80	---
Common salt	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Oil	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Premix	0.20	0.20	0.20	0.20	0.20	0.20	0.20
Chromium (g/kg)	-----	-----	0.02	----	0.04	----	0.06
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Compositions							
Dry matter, %	90.02	85.73	88.96	86.19	90.07	85.55	90.08
Crude protein, %	18.40	18.92	18.62	18.54	18.55	18.40	18.66
Crude fibre, %	3.67	4.19	4.39	4.29	3.89	4.09	4.11
M.E/Kcal.Kg	2956.69	2527.84	2685.98	2366.72	2837.97	2340.34	2643.96

Provided: Vit A-20500000iu, vit D_3-4,250,000iu, Vit. E- 250,000iu, Vit K – 8000mg, Vit B_1 – 20,000mg, Vit B_2 – 15,000mg, Vit B_6–20,0000mg,Vit B_{12} – 15.00mcg, Vit B_3- 90,000mg, Vit B5 – 40.00mg, Vit B4 – 4,000 mg, Vit C – 350,000mg, Vit B7 – 500mcg, Choline Cloride- 600,000mg, Iron – 40,000mg, Manganese – 30,000mg, Zinc- 40,000mg, Magnesium – 60,000mcg, Copper-4,000mg, Iodine- 2,000mg, Cobalt – 750mg, Selenium – 200mcg, Molybdenum-100mg, Inositol- 50,000mg, Methionine – 50,000mg, Lysine- 50,000mg, Antioxidant – 125,000mg. **T1- control** group, T2-200ppm organic chromium, T3-200ppm inorganic chromium, T4- 400ppm organic chromium, T5- 400ppm inorganic chromium, T6- 600ppm organic chromium, T7- 600ppm inorganic chromium.

Table 2 – performance characteristics of growing rabbits fed experimental diets.

a-b,c-d Means within the row with different superscripts are different at P < 0.05.T1- control group, T2- 200ppm organic chromium, T3-200ppm inorganic chromium, T4- 400ppm organic chromium, T5- 400ppm inorganic chromium, T6- 600ppm organic chromium, T7- 600ppm inorganic chromium. IWT- initial weight, FWT- final weight, ADG- average daily weight gain, DFI- daily feed intake, FCR- feed conversion ratio.

Parameter	T1 (0%)	T2 (0.02g/kg Org)	T3 (0.02g/kg In.org)	T4 (0.04g/kg Org.)	T5 (0.04g/kg In.org)	T6 (0.06g/kg Org)	T7 (0.06g/kg In.org)
IWT(g)	1333±37.56^a	1440±105.3^a	1246±121.9^b	1250±152.75^b	1257±73.11^b	1150±50^c	1290±20.82^b
FWT(g)	1680±52.92^b	1660±87.36^b	1560±147.3^c	1867±270.63^a	1580±75.50^c	1767±129.7^b	1540±70.24^c
ADG (g/day)	6.19±0.69^b	6.73±0.73^b	5.59±0.57^c	11.01±2.11^a	4.58±1.13^d	11.01±2.30^a	4.10±0.78^d
DFI(g)	110±0.00^a	103±4.44^a	105±3.18^a	105±3.48^a	103±4.41^a	108±2.18^a	93.33±4.41^b
FCR	17.75±0.36^b	15.30±0.24^c	18.62±0.23^b	9.57±1.31^d	22.47±0.56^a	9.81±1.31^d	22.54±0.39^a
Digestibility							
Crude protein	72.17±0.07^d	75.45±0.32^b	73.20±0.01^c	76.46±0.05^a	72.26±0.04^d	76.40±0.03^a	69.30±0.08^e
Crude fibre	54.36±0.08^d	55.54±0.06^c	54.54±0.15^d	57.66±0.12^b	54.36±0.08^d	58.35±0.06^a	55.39±0.03^c
Ash	65.36±0.10^b	59.48±0.21^e	59.46±0.03^e	64.24±0.02^c	60.37±0.03^d	65.94±0.01^a	60.43±0.04^d
Ether extract	81.37±0.04^a	81.54±0.00^a	75.20±0.04^d	79.52±0.01^c	80.21±0.05^b	81.51±0.03^a	72.31±0.12^e

Table 3 Carcass evaluations of growing rabbits fed varying levels organic and Inorganic chromium

Parameters	T1 (0%)	T2 (0.02g/kg Org)	T3 (0.02g/kg In.org)	T4 (0.04g/kg Org.)	T5 (0.04g/kg In.org)	T6 (0.06g/kg Org)	T7 (0.06g/kg In.org)
Pre Slaughter Weight (G)	1501.92±0.96^{b}	1479.93±0.95^{c}	1521.04±0.83^{a}	1479.93±0.90^{c}	1501.92±0.71^{b}	1521.04±0.37^{a}	1401.52±1.37^{d}
Carcass Weight (G)	620.45±0.58^{c}	614.11±0.26^{e}	628.83±0.29^{b}	628.83±0.66^{b}	615.89±0.34^{d}	642.32±0.96^{a}	574.63±0.13^{f}
Dressing %	41.36±0.58	41.85±0.40	41.41±0.40	42.05±0.82	41.15±0.35	41.85±0.59	41.49±0.38
Small Intestine (Cm)	324.00±0.58^{a}	320.87±0.40^{b}	297.79±0.19^{d}	321.24±0.24^{b}	301.48±0.58^{c}	324.41±0.44^{a}	294.49±0.43^{e}
large Intestine (Cm)	87.00±0.33^{c}	85.84±0.23^{d}	86.83±0.32^{c}	87.98±0.20^{b}	85.66±0.24^{d}	89.29±0.23^{a}	83.03±0.37^{e}
Heart (g)	3.32±0.03^{c}	3.48±0.03^{bc}	3.61±0.03^{ab}	3.52±0.02^{ab}	3.55±0.05^{ab}	3.69±0.12^{a}	3.32±0.02^{c}
Lung(g)	15.05±0.11^{b}	15.43±0.09^{b}	16.10±^{a}	15.10±0.11^{b}	15.05±0.12^{b}	15.35±0.21^{b}	15.34±0.19^{b}
Kidney(g)	9.32±0.22^{ab}	9.51±0.03^{a}	9.50±0.09^{a}	9.12±0.23^{ab}	9.30±0.02^{ab}	9.55±0.08^{a}	9.06±0.05^{b}
Stomach(g)	82.01±0.25^{a}	80.36±0.50^{b}	82.23±0.21^{a}	81.08±0.21^{ab}	81.52±0.37^{ab}	82.41±0.90^{a}	82.09±0.31^{a}
Intestine weight(g)	225.52±0.58^{a}	225.04±0.42^{a}	225.70±0.55^{a}	226.29±0.26^{a}	225.76±0.54^{a}	226.03±0.31^{a}	223.40±0.54^{b}
Head (g)	115.20±0.19^{abc}	114.84±0.19^{bc}	115.99±0.31^{a}	115.62±0.43^{ab}	115.42±0.46^{abc}	115.24±0.22^{abc}	114.57±0.22^{c}
Tail (g)	15.46±0.31^{bc}	15.69±0.03^{ab}	16.17±0.12^{a}	14.86±0.23^{c}	15.41±0.23^{bc}	16.29±0.21^{a}	14.20±0.23^{d}
Thigh (g)	176.37±0.25^{a}	175.89±0.17^{a}	175.62±0.43^{ab}	174.56±0.39^{b}	174.69±0.52^{b}	176.05±0.42^{a}	173.29±0.27^{b}
Liver (g)	35.63±0.54^{bc}	36.55±0.30^{ab}	37.08±0.11^{a}	35.97±0.27^{abc}	37.06±0.33^{a}	36.51±0.36^{ab}	35.33±0.32^{c}

a-b-c-d Means within the row with different superscripts are different at $P < 0.05$.T1- control group, T2- 200ppm organic chromium, T3- 200ppm inorganic chromium, T4- 400ppm organic chromium, T5- 400ppm inorganic chromium, T6- 600ppm organic chromium, T7- 600ppm inorganic chromium.

Discussions

According to Nworgu et al. (2000), who suggested that the range for the amount of crude protein in rabbit diets should be between 17.21 and 22.75%, thus the proximate composition of the experimental diets in this experiments demonstrated their sufficiency to provide the nutrients needed for growing rabbits. To improve the performance of growing rabbits, Fasanya and Ijaiya (1997) suggested CP levels between 16 and 20 percent, while Ugwubuike et al. (2013) found a value of 19.77 percent when growing rabbits were fed several kinds of sorghum in place of maize in a tropical environment. The experimental diets' levels of CF fell within the 10–16% range that John-Delaney advised (2006). The metabolizable energy levels of the meals supplied to developing rabbits were within the range of 2500–2800 Kcal as reported by Aduku and Olukosi (1990) and Aduku (2004) for growing rabbits in a tropical environment. The average weight gains per day of growing rabbits reported in this study (4.10g – 11.01g) were not comparable to those reported by Lambertini *et al.* (2004) (30.7g – 32.7g.) in their study on the effects of chromium yeast supplementation on growth performances and meat quality in rabbits, or by Frederic et al. (2012) (19.7g – 23.1g) in their study on the growth performances of rabbits fed palm press fiber diets. This is likely a result of the tests using hybrid male rabbits, which began right after weaning (at 35 days old), as opposed to the research, which employed composite breeds of rabbits with an average age of 90 days. According to Sahin, et al. (2001), in their study on the impact of supplemental dietary chromium on performance, some blood parameters and tissue chromium contents of rabbits, 200 or 400 ppb (0.00002g or 0.00004g) of Cr supplemented did not affect daily gain, feed intake, or FCR of weaned or growing rabbits. This is likely because the inclusion levels are much lower than those shown in this research. In their studies on the productive and physiological responses of growing rabbits fed dietary organic chromium addition, Ibrahim et al. (2010), Mervat Ghazal et al. (2013), and Shimaa et al. (2019) found that the 8addition of Cr-yeast had a significant impact on the final body weight (BW), average daily gain (ADG), and feed efficiency of growing rabbits. This suggests that the chromium could act as a metabolic modulator to balance, therefore, it is significant to note that experimental animals performed noticeably better on the organic supply of chromium than the inorganic; this is most likely due to organic chromium's higher levels of absorption than inorganic chromium. As the amount of organic chromium inclusion grew, the FCR was likewise impacted because of the rising levels. The average carcass yield in this study ranged from 41.36 to 42.05 percent, which was comparable to the 46.86 to 51.55% reported for rabbits fed cassava root meal by Eshiet et al. (2011) and the findings of Ebegbulem et al. (2017), whose study focused on the growth characteristics and carcass traits of weaned rabbits fed *Alchornea cordifolia* leaf meal. The identical head weights are consistent with the earlier research on rabbits fed diets based on plantain peel. The non-dietary influence on limb weight validates the conclusions made by Adama and Haruna (2002) when they fed fibre-rich diets to rabbits. The lower levels of chromium that were available for absorption in these treatments may be the cause of the lower significant values for the carcass weight, as well as the thigh weights at 0.02g/kg (T3) and 0.06g/kg (T7) inorganic chromium, and the lack of a clear pattern in tail weights across dietary treatments may be due to age, sex, or genetic factors (Adama and Haruna,2002). It is probable that the greater organ weights with 0.06g/kg organic chromium (T6) inclusion are due to the activity of those organs in the detoxification of potential anti-nutrients in these diets (Adama and Haruna,2002). The weights of the majority of carcass components were generally impacted by the addition of organic and inorganic chromium supplements. This was in contrast to the findings of Sankhyan et al. (1991), Ibrahim et al. (2017), and Adama and Haruna (2002) but agreed with Collin's findings in 1976, who investigated the effects of 10 and 17% crude fiber in rabbit diets and found that the carcass yield was lower at the higher crude fibre level. The rabbits on treatment 5 (0.04 g/kg inorganic chromium) had considerably ($p>0.05$) larger liver weights, which may be a symptom of liver overload. This might be a result of the inorganic chromium's slow rate of absorption.

Conclusion

In conclusion, the quantities of organic and inorganic chromium supplementation in the diets employed in this study had a substantial impact on the performance and carcass traits of developing rabbits, including average daily weight gains, feed conversion ratios, and feed efficiency. This study has demonstrated that although the various levels of chromium inclusion had a substantial impact on the numerous parameters examined, organic chromium inclusion, particularly at concentrations of 0.04g/kg (T4) and 0.06g/kg (T6), had a higher impact.

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