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Research Application Summary

Lemon grass (*Cymbopogon citratus*) as a herbal feed additive to improve productive performance of rabbits (*Oryctolagus cuniculus*)

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Abstract

The study evaluated the effect of different inclusion levels of Lemon grass meal (LGM) on the productive performance of rabbits. Fifteen New Zealand White rabbits, aged 11-weeks (mean weight 939 g) were randomly put into three treatment groups of five replicates each. The experimental diet were composed of shade-dried Lemon grass, milled and mixed at 0.0, 5.0 and 10.0 g per 100 g of concentrate basal diet, offered as control (T_0) i.e., treatment groups T_1 (0.5) and T_2 (11.0 g), respectively. Feed and water were provided *ad-libitum.* Body weight and weight gains for the T_1 group were significantly ($P<0.05$) highest than the T_2 and T_0 groups, in that order. A similar trend was observed for the Feed Conservation Ratio (FCR). Likewise, slaughter weight, de-furred weight, and dressed weight were significantly ($P<0.05$) highest in the T_1 group, but the T_2 had the highest dressing %. The haematological indices measured were within the normal standards. Therefore, Lemon grass (LG) can be used as a feed additive in rabbit diets could be used to improve performance in weight gains of the rabbits.

Keywords: Carcass, growth, haematology, Lemon grass meal, meat, rabbits, serum biochemistry

Abstract

L'étude a évalué l'effet de différents niveaux d'addition de farine de citronnelle (LGM) sur la performance productive des lapins. Quinze lapins blancs de Nouvelle-Zélande, âgés de 11 semaines (poids moyen de 939 g) ont été répartis au hasard dans trois groupes de traitement de cinq répétitions chacun. Le régime expérimental était composé de citronnelle séchée à l'ombre, broyée et mélangée à 0,0, 5,0 et 10,0 g par 100 g de régime de base concentré, offert comme témoin (T0), c'est-à-dire les groupes de traitement T_1 (0,5) et T_2 (11,0 g), respectivement. La nourriture et l'eau ont été fournies ad-libitum. Le poids corporel et les gains de poids du groupe T_1 étaient significativement ($P<0,05$) plus élevés que ceux des groupes T_2 et T_0, dans cet ordre. Une tendance similaire a été observée pour le ratio de conservation des aliments (FCR). De même, le poids à l'abattage, le poids à la déglutition et le poids habillé étaient significativement ($P<0,05$) plus élevés dans le groupe T_1, mais le groupe T_2 avait le pourcentage d'habillage le plus élevé. Les indices hématologiques mesurés se situaient dans les normes normales. Par conséquent, la citronnelle (LG) peut être utilisée comme un additif alimentaire dans les régimes des lapins pour améliorer les performances et les gains de poids des lapins.

Mots-clés : Carcasse, croissance, hématologie, farine de citronnelle, viande, lapins, biochimie du sérum.

Introduction

Various feed additives have been used in animal nutrition to promote growth and production; amongst these are enzymes, amino acids, pigments, minerals, vitamins, and antibiotics, as well as tropical forages, agricultural by-products, herbs, and leaf meals. Lemon grass (LG) has been used in many regions of the world as a medicinal plant used as a feed additive (Mukhtar *et al*., 2012; Ganguly 2013a). Lemon grass (Fig. 1), a tall perennial grass comprising of about 55 species, is native to warm regions and grows in almost all tropical and subtropical countries. It also thrives well on marginal soils (Cheel *et al*., 2005). Citral (Lemonol), a biologically active constituent (monoterpenoid) in Lemon grass, constituting >75% (w/w) of its essential oil (Ha *et al*., 2008) gives off its lemony scent and is postulated to be responsible for most of its actions (Devi *et al*.,2011). As a herbal feed additive, it is widely used in traditional medicine in most parts of the world (Runnie *et al*., 2004; Negrelle and Gomes 2007) due to its therapeutic properties. It is also analgesic, anti-depressant, antimicrobial, antipyretic, antiseptic, anti-carcinogenic, bactericidal, and tonic (Tiwari *et al*., 2010).

Herbal feed additives (phytobiotics or botanicals) are plant-derived compounds incorporated into diets to enhance livestock productive performance, by improving the feed properties, and the quality of products derived from those animals (Ganguly, 2013b; Hayam, *et al*., 2013). The use of LG as a performance-enhancer has been reported in several studies (Mmereole, 2010; Omer, *et al*., 2010; Mukhtar, *et al*., 2012). It is therefore believed that some benefits could be exploited from Lemon grass in rabbit production. This would be key for enhancing growth and the overall production performance and thus replace the antibiotic growth promoters. As such, it is essential that the optimal level of Lemon grass inclusion in diets for good rabbit production be identified. Hence, this study was conducted to evaluate the growth performance, carcass and blood indices of rabbits fed diets containing Lemon grass as a herbal feed additive.

Figure 1: Lemon grass (*Cymbopogon citratus*)

Materials and Methods

A total of 15 weaned New Zealand White rabbits at 11 weeks old with mean weight of 939 g were randomly put into three groups with similar body weights. Each group comprised of five replications (one male and four females to eschew sex effect). The study was laid out in a completely randomized design where three dietary treatments were randomly allotted to the groups. A concentrate diet (18% crude protein) was compounded to form the basal diet upon which different levels of Lemon grass meal (LGM) were added. At the point of serving, the LGM was incorporated into the diets at 0.0 g,

5.0 g and 10.0 g per 100 g concentrate basal diet (Table 1), representing dietary treatment offered to the control (T_0) and treatment groups (T_1 and T_2) respectively and provided *ad libitum* feed and as well as for water intake. All sick rabbits were isolated and treated. The chemical compositions of the diets (Table 2) were determined according to the procedure outlined by A.O.A.C. (1990).

Table 1. Experimental diets ingredients and LGM inclusion levels

Ingredients (kg)	LGM inclusion level		
	T_0	T_1	T_2
	0.0 g LGM	5.0 g LGM	10.0 g LGM
LGM (g)	-	5.0	10.0
Maize	50.0	50.0	50.0
Wheat Bran	22.0	22.0	22.0
Soybean meal	26.5	26.5	26.5
Salt	0.5	0.5	0.5
*Vitamin/mineral premix	0.5	0.5	0.5
Dicalcium Phosphate	0.5	0.5	0.5
TOTAL	100	100	100

*Vitamin/mineral premix composition: Vit. A (8.000 U.I), Vit. D3 (1.500 U.I), Vit. E (2.500 U.I), vit. K3 (1.000 mg), Vit B2 (2.000 mg), Vit. B12 (5 mg), Nicotinic acid (8 mg), Calcium Panthotenate (2 mg), Antioxidant (10 mg), Folic acid (500 mg), Choline (50 mg), Manganese (50 mg), Zinc (40 mg), Copper (4.5 mg), Cobalt (100 mg), Iodine (1 mg) and Selenium (100 mg).

Table 2. Chemical analysis of Lemon grass meal (LGM) and experimental diets

Composition (%)	Treatments			
	LGM	T_0	T_1	T_2
		0.0 g LGM	5.0 g LGM	10.0 g LGM
Crude Protein	5.30	18.00	18.08	18.05
Ether Extract	3.00	2.00	2.90	2.10
Crude Fibre	23.26	2.20	25.20	26.20
Ash Content	9.50	5.50	5.60	5.55
Moisture Content	15.50	12.50	10.50	12.00
Nitrogen Free Extract	43.44	59.80	37.72	36.10
Metabolisable Energy (Kcal kg^{-1})	N/A	3053.2	3053.2	3053.2

The Lemon grass meal (LGM) was prepared by harvesting fresh Lemon grass leaves which were chopped into pieces and shade-dried at room temperature for a week; depending on the ambient temperature and the quantity of leaves spread on the floor. The dried product was hammer milled through a 2 mm sieve to obtain the LGM which was stored air-tight for incorporation into the ration.At the start, the rabbits were weighed to obtain their initial body weight and subsequently weighed weekly to obtain the daily body weights and weight gains. Other indices recorded include daily feed intake, daily growth rate, total weight gain, and feed conversion ratio (FCR) for growth measurements. The haematological, and serum biochemical indices were taken at the end of the

experiment for analyses as described in Özkan *et al*., (2012) following blood collection method in van Praag (2015). All data obtained were analysed for variance using the GLM procedure of GenStat (2014). Differences in treatment means of significant effect were separated at a 5% significant level using the least significant difference test.

Results and Discussion

Chemical analysis of the experimental diets (Table 2) showed that the diets met the nutrient requirements of rabbits for growth and were within the nutrient allowance for weaner rabbits (Akinnusi *et al*., 2009; Omer, *et al*., 2010). Growth performance of weaner rabbits is best at dietary CP of 18-20% (Lei *et al*, 2004). However, the NFE compositions were higher in the control diet which is a concentrate basal diet without LGM. Also, the CF of T_1 and T_2 diets were higher than in the control diet. Grasses have a high fibre content (McDonald *et al*., 2011). As such the LGM content in those diets could have increased the CF composition. The composition of GM is said to vary according age/stage of maturity, and edaphic factors at the geographic location (Ewansiha, *et al*. 2012; Idrees *et al*. 2012). LG used in this study was harvested from matured plants around December, a harmattan period in Ghana. This could explain the high levels of the CF content of the diets with LGM.

Effects of Lemon Grass Meal (LGM) inclusion on the growth performance of rabbits The result of the growth performance of rabbits fed diets with varying LGM levels is presented in Table 3. The daily feed intake as well as protein intake of the rabbits were not influenced ($P>0.05$) by the treatments. However, the dietary inclusion of LGM resulted in a significantly ($P<0.05$) higher body weight and weight gains in the treatment groups compared to the control. A similar trend was observed in the protein efficiency ratio (PER) where body weight and weight gain, and PER, were higher at lower LGM levels. The trend in body weight and weight gain in the groups progressed right from week 1 but was significantly ($P<0.05$) higher at week 5 and this trend continued to the end of the experimental period at week 7 (Fig. 2).

Table 3. Growth performance of rabbits fed diets containing Lemon Grass Meal (LGM)

Parameter	Treatments			LSD	P
	T_0 0.0 g LGM	T_1 5.0 g LGM	T_2 10.0 g LGM		
Mean Initial Body Weight (g)	939	939	940	112.4	1.000
Mean Daily Feed Intake (g\rabbit\ day)	69.45	71.28	72.56	7.82	0.691
Mean Final Body Weight (g)	1565[a]	1878[b]	1717[c]	133.9	0.001
Mean Total Body Weight gain (g)	627[a]	939[b]	777[c]	86.0	<.001
Mean Daily Weight Gain(g)	12.79[a]	19.17[b]	15.86[c]	1.755	<.001
F.C.R (Feed/ Gain)	5.46[a]	3.74[b]	4.59[c]	0.660	<.001
Protein Intake (g/rabbit/day)	12.50	12.89	13.10	1.413	0.655
PER (Gain/ Protein Intake)	1.027[a]	1.499[b]	1.212[c]	0.1835	<.001

[a], [b], [c]: Means with different superscripts in the same row are significantly different at 5% level. F.C.R = Feed Conversion Ratio. LSD = Least significant differences of means. PER= Protein Efficiency Ratio

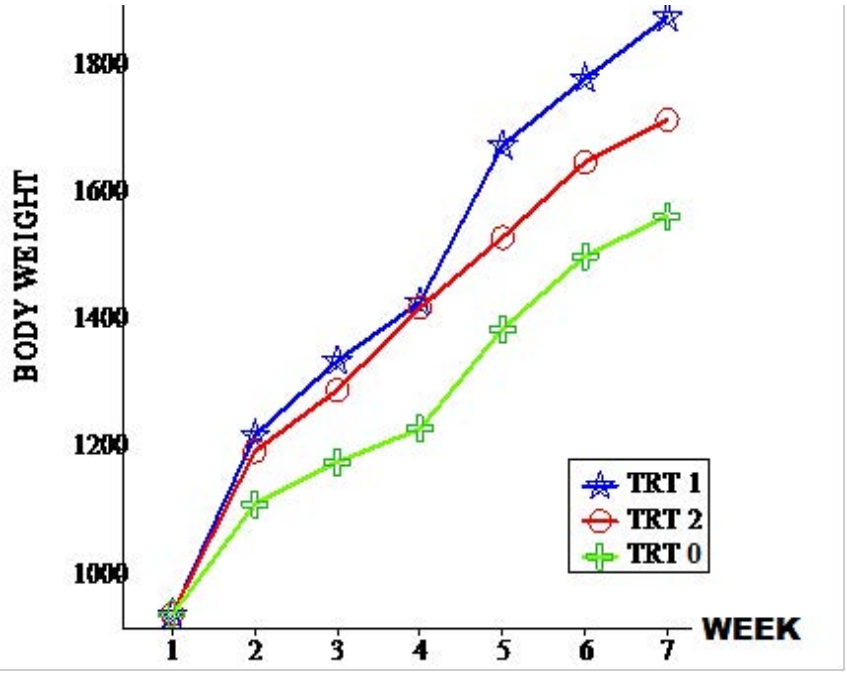

Figure 2. Weekly body weight of rabbits fed different rates of Lemon grass meal

This trend of body weight and weight gains of the rabbits in this experiment agrees with the findings by Omer, *et al*., (2010) that the dietary inclusion of 0.5% of Lemon grass (LG) to rabbit diet improved the final weight, body weight gain and average daily gain significantly ($P<0.05$). Similar observations were made by other researchers working on substituting antibiotic growth promoters with herbs and other biological feed additives (Mmereole, 2010). Subha (2013) stated that the natural herbal growth promoters of which Lemon grass is included, remain active throughout the gastrointestinal tract and as a consequence, it exerts broad-spectrum antimicrobial action, which enhances nutrient utilization by exhibiting improvement in overall growth performance; and by augmenting the gastrointestinal histomorphology thereby enhancing the host immunity.

Regarding the FCR, the quantity of feed consumed to gain 1.0 kg of body weight was significantly ($P<0.05$) lower in the rabbits fed at lower LGM level than those in the T_2 and T_0. Indeed FCR of rabbits has been reported to be significantly ($P<0.05$) improved by the addition of LG (Omer *et al*., 2010). Aboul-Fotouh *et al*. (2000) and Hanafy *et al*. (2009) found that Lemon grass decreased FCR (DMI kg/kgFCM). These variations in the response of the experimental rabbits is a result of the chemical constituents of the Lemon grass, possibly, citral which is claimed to be responsible for most of its effects (Shaaban, 2009; Devi, *et al*., 2011). The PER found in this study lie within the range (1.2-2.4) established for plant proteins. Hence, the variations in the body weight and weight gain among groups is unlikely to emanate from the feeding value of dietary protein. LG is reported to have good biological effect that improve growth performance and digestion coefficients of rabbits when added to feed or water (Omer, *et al*., 2010; Ganguly, 2013a). Moreover, essential oils in LG can improve absorption and nutrient utilization as it enhances the activity of digestive enzymes (Shaaban, 2009; Subha, 2013)

Effects of LGM on the carcass and organ characteristics of rabbits. The effect of LGM on carcass and organ characteristics (Table 4) indicates that dietary LGM inclusion had significant ($P<0.05$) influence on slaughter weight, de-furred weight and dressed weight. This was also true for the dressing percentage.

Table 4. Carcass and organ characteristics of rabbits fed diets containing Lemon Grass Meal

Variable	Treatments			LSD	P
	T_0 0.0 g LGM	T_1 5 g LGM	T_2 10 g LGM		
Carcass					
Live weight (g)	1610.0[a]	1867.0[b]	1736.0[ab]	128.4	0.018
Slaughter weight (g)	1602.0[a]	1857.0[b]	1724.0[ac]	129.9	0.019
De-furred weight (g)	1556.0[a]	1792.0[b]	1741.0[bc]	170.3	0.042
Dressed Weight (g)	1258.0[a]	1547.0[b]	1541.0[b]	148.2	0.004
Dressing (%)	78.22[a]	82.86[a]	88.78[b]	5.867	0.024
Organ					
Heart weight (g)	4.00	5.00	5.50	4.684	0.631
Liver weight (g)	48.5	50.0	47.5	12.60	0.827
Spleen weight (g)	1.00	1.25	0.75	2.054	0.761
Kidney weight (g)	12.50	12.50	10.50	2.250	0.103

[a, b, c]: Means with different superscripts in the same row are significantly different at 5% level. LSD= Least significant differences of means

Consistently, the T_1 group recorded the highest weights across all carcass parameters. Also, the dressing percentage measured was significantly ($P<0.05$) high in the treatment groups compared to the control group. Weight of internal organs, on the other hand, were not significantly ($P>0.05$) influenced by dietary LGM inclusion. Results on dressing percentages are in line with reports that the inclusion of LGM had no adverse effect on the performance and internal organs of rabbits (Omer *et al*., 2010).

Effects of LGM on the haematological and serum biochemical indices of rabbits. The effect of LGM on the blood constituents of the rabbits (Table 5) showed that white blood cells (WBC), red blood cells (RBC), haemoglobin (HGB) and haematocrit (HCT) components of the rabbits were significantly ($P<0.05$) influenced by LGM inclusion in diets. However, the lymphocytes, MCV, MCHC, and platelets (PLT) were not significantly ($P>0.05$) affected by the dietary inclusion of LGM. All the values were within the standard ranges (MediRabbit, 2015). There was mange and pneumonia incidence in the control (T_0) group which may have challenged them to produce more cells in efforts to combat it. Conversely, LGM has some phytobiotics properties (65-85% Citral) which could fight potential pathogenic threats (Devi *et al*., 2011).

It appears therefore, that there was no need for the body system of rabbits fed on the LGM inclusive diets to produce extra WBC. Except for the serum cholesterol concentration (SCC), the total protein, albumin, and globulin component of the rabbits were not significantly ($P>0.05$) influenced by the LGM inclusion in the diet. The rabbits fed on the control diet recorded significantly ($P<0.05$) higher SCC compared to those on the T_2 and T_1 diets. However, the SCC of the T_1 and the T_2 dietary groups did not significantly ($P>0.05$) differ. Melillo (2007) and (Etim *et al*., 2014) established that health and physiological status of an animal may be achieved using changes in haematological and biochemical parameters. Therefore, this implies that lemon grass could be added to rabbit diets to improve their health status without any adverse effects.

Table 5. Effect of Lemon Grass Meal on the Haematological and serum biochemical indices of rabbits

Variable	Treatments			LSD	P
	T_0	T_1	T_2		
	0.0g LGM	5g LGM	10g LGM		
Haematology					
WBC (×103 /µl)	6.275 [a]	4.750[ab]	3.250 [b]	2.2105	0.038
RBC (10 6/ µl)	5.4925[bc]	6.9800[a]	5.4875[b]	1.12036	0.022
HGB (g/dl)	11.15[bc]	14.28[a]	11.05[b]	1.618	0.002
HCT (%)	36.7[a]	46.8[b]	36.9[a]	6.42	0.009
Lymphocytes (%)	52.0	65.0	60.0	57.7	0.876
MCV (fl)	66.83	66.92	67.40	3.971	0.941
MCHC (g/dl)	30.62	30.62	29.98	1.284	0.450
PLT (×103 /µl)	193.000	149.000	61.825	234.22	0.466
Serum Biochemistry					
Total Protein (g/ dl)	5.86	5.96	5.93	0.908	0.966
Albumin (g/dl)	3.16	3.39	3.19	0.623	0.665
Globulin (g/dl)	2.56	2.57	2.62	0.887	0.988
SCC (mg/dl)	38.60[a]	35.55[b]	36.38[bc]	1.563	0.005

[a], [b], [c]: Means with different superscripts in the same row are significantly different at 5% level. LSD= Least significant differences of means. WBC=White Blood Cells, RBC= Red blood cells, HGB= haemoglobin, HCT= Haematocrit, MCV = mean corpuscular volume PLT =platelet, SCC, serum cholesterol concentration.

Conclusion

From these results obtained, we conclude that lemon grass meal as a herbal feed additive could be included in the diets of rabbits up to 10 g per 100 g of concentrate to improve growth performance, carcass traits, and the general health status of rabbits. However, there is need to carry out further research to establish the specific rabbit disease (s) that lemon grass meal can effectively control.

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