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# Dietary Lysine Requirement for Optimal Productivity and Carcass Characteristics of Growing Indigenous Venda Chicken

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## ABSTRACT

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A study was conducted to determine the levels of dietary lysine requirements for optimal productivity and carcass characteristics of growing indigenous Venda chicken from 1–13 wks of age involving 200 unsexed day-old indigenous Venda chicks during first experiment and 160 female chicks during the second experiment. In each feed trial, the chicks were randomly allocated to four dietary treatments with varying lysine levels $L_6$ (0.6%), $L_8$ (0.8%), $L_{10}$ (1.0%) and $L_{12}$ (1.2%) in a completely randomized design. L-Lysine-HCl at the expense of inert filler (sand) was used to balance the diet. The initial LW of the birds were taken and at weekly intervals thereafter. At 91d of age all the chickens in each pen were slaughtered and the carcass and haematological parameters determined. Results showed that feed intake, growth rate at the starter and growing phases were influenced ($P<0.05$) by dietary lysine level. Carcass weight, dressing percentage, breast meat and drumstick weights were also influenced ($P<0.05$) by dietary lysine level. However, dietary lysine level had no effect ($P>0.05$) on FCR, metabilosable energy and mortality at starter and growing phases. Furthermore, thigh, wings, fat pad weights and haematological parameters were not influenced ($P>0.05$) by the dietary lysine treatments. Dietary lysine levels of 0.97 and 1.07% DM optimized feed intake and growth rate at the starter phase, respectively. While dietary lysine levels of 0.82 and 0.94 % DM optimized feed intake and growth rate, respectively, at the growing phase. Dietary lysine levels of 0.91, 0.96, 0.98 and 0.93% DM optimized carcass weight, dressing percentage, breast meat and drumstick weights, respectively. These results have implications on ration formulation for indigenous chickens.

**Keywords:** Carcass characteristics, Haematological, Lysine, Requirements.

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## INTRODUCTION

The scavenging village chickens play a significant role in poverty alleviation and enhancement of gender equity among the disadvantaged communities (King'ori *et al.,* 2003; Tadelle, 1996). Although there is ample evidence of the important role that local chicken production plays in the lives of rural households, these chickens have low growth rates and high mortality rates (King'ori *et al.,* 2003). The causes of low growth and high mortality rates include poor nutrition, poor genetic potential, diseases and poor management skills. However, because nutrition plays the most important role in influencing growth in chickens as suggested by McDonald *et al.* (2011) in order to improve and maximize productivity, it becomes important that the optimal nutritional requirements of the chickens must be met. For example, lysine is one of the essential amino acids in poultry diets and all amino acids are related to it in an ideal ratio (Baker and Han, 1994). Thus, it is important to have an accurate lysine requirement on a digestibility basis for the group of animals for which the diets are being formulated. Inaccurate determination of the lysine requirement will result in erroneous estimate of all other amino acids. Regrettably, review of literature revealed scanty (Mandal *et al.,* 2003; Deo *et al.,* 2014) research has been conducted to determine the lysine requirements for indigenous chickens. This study was conducted to determine dietary lysine requirement for optimal productivity and carcass characteristics of indigenous Venda chickens.

## MATERIALS AND METHODS

This study was conducted at the Animal Unit of the University of Limpopo, South Africa. The ambient temperatures around the study area ranged between 20 and 36°C during summer and between 10 and 25°C in winter. It receives a mean annual rainfall of less than 400 mm (Kutu and Asiwe, 2010).

In first feeding trial, two hundred unsexed day-old indigenous Venda chicks were randomly allocated to four dietary treatments of varying digestible lysine levels indicated as $L_6$ (0.6), $L_8$ (0.8), $L_{10}$ (1) and $L_{12}$ (1.2) % of DM. Each treatment was replicated five times in a completely randomized design. Each replicate had ten chicks, thus, 20 floor pens measuring 2.5 $m^2$ in area were used. The formulated experimental diets were isonitrogenous (180 g CP/kg DM feed, based mainly on maize and soya beans) and isocaloric. L-Lysine-HCl at the expense of inert filler (sand) was used to balance the diet (Table 1). The birds were offered feed and fresh water *ad libitum.* Twenty three hours of light was available per day. The first part of the experiment was terminated when the chickens were 49 days.

The second trial was done to determine the effect of varying dietary lysine levels for optimum productivity and carcass characteristics of indigenous female Venda chickens aged 50 to 91 days. The design, treatments and layout for the second part of the experiment were similar to those in the first experiment, except that 160 seven weeks old indigenous female Venda chickens were randomly allocated to four dietary treatments. Each treatment was replicated four times with ten birds per replicate. Prior to this experiment, the

Table 1. Ingredients and nutrient composition of the experimental diets

| Particulars | Period | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Starter | | | | Grower | | | |
| | $L_6$ | $L_8$ | $L_{10}$ | $L_{12}$ | $L_6$ | $L_8$ | $L_{10}$ | $L_{12}$ |
| *Ingredients (%)* | | | | | | | | |
| Maize | 43.16 | 43.16 | 43.16 | 43.16 | 48.25 | 48.25 | 48.25 | 48.25 |
| Wheat bran | 28.11 | 28.11 | 28.11 | 28.11 | 23.11 | 23.11 | 23.11 | 23.11 |
| Full-fat soya | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 | 2.00 |
| Hipro soya | 22.05 | 22.05 | 22.05 | 22.05 | 21.81 | 21.81 | 21.81 | 21.81 |
| Limestone | 2.63 | 2.63 | 2.63 | 2.63 | 2.71 | 2.71 | 2.71 | 2.71 |
| Salt | 0.44 | 0.44 | 0.44 | 0.44 | 0.44 | 0.44 | 0.44 | 0.44 |
| Methionine | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 |
| Threonine | 0.05 | 0.03 | 0.03 | 0.03 | 0.05 | 0.03 | 0.03 | 0.03 |
| Choline | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 | 0.07 |
| Vit/Min PMX | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 | 0.29 |
| Lysine (HCL) | 0.52 | 0.73 | 0.94 | 1.02 | 0.65 | 0.75 | 1.06 | 1.09 |
| Fillers | 0.48 | 0.29 | 0.08 | 0.00 | 0.42 | 0.34 | 0.03 | 0.00 |
| *Determined analysis (%)* | | | | | | | | |
| Dry matter | 88.48 | 88.21 | 88.64 | 88.55 | 88.48 | 88.21 | 88.64 | 88.55 |
| Ash | 6.43 | 6.57 | 6.52 | 6.45 | 6.43 | 6.57 | 6.52 | 6.45 |
| Crude protein | 17.99 | 17.96 | 17.81 | 17.88 | 17.99 | 17.96 | 17.81 | 17.88 |
| Ether extract | 3.49 | 3.44 | 3.51 | 3.64 | 3.49 | 3.44 | 3.51 | 3.64 |
| Crude fiber | 3.37 | 3.40 | 3.38 | 3.27 | 3.37 | 3.40 | 3.38 | 3.27 |
| Methionine | 0.61 | 0.59 | 0.62 | 0.62 | 0.61 | 0.59 | 0.62 | 0.62 |
| Lysine | 0.61 | 0.79 | 1.02 | 1.21 | 0.62 | 0.81 | 1.02 | 1.21 |
| ME (MJ/kg) | 11.79 | 11.79 | 11.78 | 11.88 | 12.77 | 12.70 | 12.78 | 12.71 |

chickens were fed a 18.0% CP and 12.14 MJ ME/kg DM diet to meet their nutritional requirements according to NRC (1994). These two parts of the experiment were carried out simultaneously between January and March, 2013.

The initial live weights of the birds were taken and at weekly intervals thereafter. Feed intake, growth rate, feed conversion ratio and digestibility were determined according to the procedures of McDonald *et al*. (2011). At 91 days of age blood samples were collected from jugular vein during slaughtering. The blood was received in a 10 ml test tube containing ETDA. Haematological parameters (red blood cells, white blood cells, haemoglobin, packed volume cells, mean corpuscular volume, mean corpuscular haemoglobin and mean corpuscular haemoglobin concentration) were measured using a Beckman Coulter ACT diff Haematology Analyzer (Beckman-Coulter, USA). All the remaining chickens in each pen from the second part of the experiment were slaughtered by cervical dislocation as recommended by the University of Limpopo Committee on

Animal Ethics. Carcass weight, breast meat, drumstick, thigh, wing and fat pad weights were determined.

Dry matter contents of the diets, refusals and faecal samples were determined as described by AOAC (2005). The gross energy of the diets and faecal samples were determined (AOAC, 2005) using a bomb calorimeter (Animal Production Laboratory, University of Limpopo). The apparent metabolisable energy contents of the diets were determined according to AOAC (2005) official methods.

Data in both trials were analysed by one-way analysis of variance (SAS, 2008). Treatment means were separated using the least significant difference (95 % confidence level). The responses in feed intake, growth rate, carcass weight, dressing percentage, breast meat yield, drumstick weights to lysine levels were modelled using the following quadratic equation (SAS, 2008):

$$Y = a + b_1x + b_2x^2$$

Where Y = feed intake, growth rate, carcass weight, dressing percentage, breast meat, and drumstick weight; a = intercept; b = coefficients of quadratic equation; x = dietary lysine level and $-b_1/2b_2$ = x value for optimum response. The quadratic model was fitted to the experimental data by means of the NLIN procedure of SAS (SAS, 2008). The quadratic model was used because it gave the best fit.

## RESULTS AND DISCUSSION

Results of the present study showed that in the starter phase (Table 2), dietary lysine had effect ($P<0.05$) on feed intake and growth rate. Chickens offered dietary lysine levels of 8, 10 or 12 g/kg DM feed had similar ($P>0.05$) feed intakes. Similarly, chickens offered dietary lysine levels of 6, 10 and 12 g/kg DM of feed had the similar ($P>0.05$) feed intakes. However, feed intakes of chickens offered a dietary lysine level of 8 g/kg were higher ($P<0.05$) than those of chickens offered a dietary lysine level of 6 g/kg DM feed. These results are in line with those of Safamehir *et al*. (2008) who observed that lysine HCl supplementation increased feed intake of Ross broiler chickens aged 1– 21 days. Similarly, Solberg (1971) observed that lysine supplementation increased feed intake of white Plymouth chickens. However, Peryankarage *et al*. (2008) reported that dietary lysine supplementation had no effect on feed intake of female broiler chickens.

Chickens offered a dietary lysine level of 10 g/kg DM feed had higher ($P<0.05$) growth rates than those offered a dietary lysine level of 12 g/kg DM feed. Likewise, chickens on a dietary lysine level of 12 g/kg DM feed had higher ($P<0.05$) growth rates than those on an 8 g/kg DM feed which in turn had higher ($P<0.05$) growth rates than those chickens offered a dietary lysine level of 6 g/kg DM feed. Holsheimer and Veeerkamp (1992) reported that increasing the lysine content in the diets of Arbor Acres and Ross broiler chickens resulted in significant improvement in body weight gain between 1 and 21 days. Similarly, Holsheimer and Ruesink (1998) observed that at 21 days old, increase in dietary lysine improved the body weight gain.

Table 2. Effect of dietary lysine on performance of Venda chickens upto 49d of age

| Variable | Dietary groups† | | | | SEM |
|---|---|---|---|---|---|
| | $L_6$ | $L_8$ | $L_{10}$ | $L_{12}$ | |
| Feed intake (g/d) | 30.12[b] | 39.12[a] | 36.02[ab] | 36.02[ab] | 1.288 |
| LW gain (g/d) | 7.1[d] | 8.5[c] | 9.0[a] | 8.9[b] | 0.336 |
| FCR | 4.24 | 4.60 | 4.00 | 3.60 | 0.270 |
| Mortality (%) | 0.34 | 0.39 | 0.44 | 0.34 | 0.027 |

†Basal diet supplemented with lysine (g/kg DM) at 6 ($L_6$), 8 ($L_8$), 10 ($L_{10}$) and 12 ($L_{12}$).

[ab]Means in the row not sharing a common superscript are significantly different (P<0.05).

At the grower phase (Table 3), dietary lysine treatment had effect on feed intake and growth rate. Chickens offered dietary lysine levels of 6, 8 or 10 g/kg DM feed had similar feed intakes; their intakes were, however, higher (P<0.05) than those of chickens offered a dietary lysine level of 12 g/kg DM feed. Bregendahl *et al.* (2002) found significant increases in feed intake of broiler chicks fed a 20% amino acid supplemented diet compared to those fed a control diet. Similarly, Sterling *et al.* (2003) reported that supplementation of lysine resulted in more feed consumption as compared to the high CP diet with normal lysine levels.

Growth rates of chickens on dietary lysine levels of 8, 10 or 12 g/kg DM feed were similar (P>0.05). Chickens on dietary lysine levels of 6, 8 or 12 g/kg DM feed also had similar (P>0.05) growth rates. However, chickens offered a dietary lysine level of 10 g/kg DM feed had higher growth rates than those chickens on 6g lysine/kg DM feed. These results are different from those of Kidd *et al.* (1997) who reported that 12g of lysine/kg DM feed is needed for improved body weight gain. Also, in another trial, Kidd and Fancher (2001) concluded that dietary lysine for minimal and maximal performance ranges between 11.8 and 12.2 g/kg DM feed in broiler chickens. The reason for these differences in lysine requirement for improved growth rate or weight gain might be attributed to breed differences since it is known that broiler chickens are

Table 3. Effect of dietary lysine on performance of Venda chickens from 50 to 91d of age

| Variable | Dietary groups† | | | | SEM |
|---|---|---|---|---|---|
| | $L_6$ | $L_8$ | $L_{10}$ | $L_{12}$ | |
| Feed intake (g/d) | 84.89[a] | 83.61[a] | 87.91[a] | 78.83[b] | 1.141 |
| LW gain (g/d) | 16.30[b] | 19.30[ab] | 22.10[a] | 17.90[ab] | 0.094 |
| FCR | 5.21 | 4.33 | 4.00 | 4.40 | 0.280 |
| Mortality (%) | 0.04[a] | 0.01b[bc] | 0.00[c] | 0.02[b] | 0.005 |

†Basal diet supplemented with lysine (g/kg DM) at 6 ($L_6$), 8 ($L_8$), 10 ($L_{10}$) and 12 ($L_{12}$).

[abc]Means in the row not sharing a common superscript are significantly different (P<0.05).

fast growing and will, thus, require higher nutrients for their growt has observed by Mack *et al*. (1999) in Isa and Ross broiler chickens

Carcass characteristics results showed that dietary lysine treatments had effect ($P<0.05$) on carcass weights, dressing percentage, breast meat and drumstick weights (Table 4). Chickens offered dietary lysine levels of 8, 10 or 12 g lysine/kg DM feed had similar ($P>0.05$) carcass weights and dressing percentages. Similarly, chickens on dietary lysine levels of 6, 8 or 12 g lysine/kg DM feed had similar ($P>0.05$) carcass weights and dressing percentages. Chickens offered a 10g lysine/kg DM feed level, however, had higher ($P<0.05$) carcass weights and dressing percentages than those on a dietary lysine level of 6 g/kg DM feed. Chickens on a 10g lysine/kg DM feed level had higher ($P<0.05$) breast meat and drumstick weights than those of chickens offered dietary lysine levels of 6, 8 or 12 g/kg DM feed. Chickens on an 8g lysine/kg DM feed level had higher ($P<0.05$) breast meat and drumstick weights than those on dietary lysine levels of 6 or 12 g/kg DM feed which had similar ($P>0.05$) breast meat and drumstick weights. The thigh, wing and fat pads weights were not affected ($P>0.05$) by dietary lysine treatments. Araujo *et al*. (2005) observed improvement in breast percentage, carcass yield and part percentages when lysine levels were increased. Other studies showed that higher lysine levels resulted in better carcass and part yields (Nasr and Kheiri, 2012; Han and Baker, 1991). Rezaei *et al.* (2004) showed that a positive response in breast meat yield was achieved by increasing lysine levels in the diet. Similarly, Holsheimer and Ruesink (1998) showed that breast meat yield was increased in male broiler chickens fed diets containing increasing lysine levels from 1 to 14 days of age.

In the present study results indicated that dietary lysine levels of 9.70 and 10.65 g/kg DM feed optimized feed intake and growth rates at the starter phase (Table 5). NRC 1994 recommended an 11g of lysine/kg DM feed for optimal feed intake in broiler chickens aged 1 to 21 days. Kidd *et al*. (1997) reported that 12g of lysine/kg DM feed is needed for improved body weight gain while Kidd and Fancher (2001) concluded that

Table 4. Effect of lysine on carcass characteristics of female Venda chickens aged 91d

| Variable | Dietary groups† | | | | SEM |
|---|---|---|---|---|---|
| | $L_6$ | $L_8$ | $L_{10}$ | $L_{12}$ | |
| Carcass weight (g) | $964.67^{b}$ | $1168.70^{ab}$ | $1197.97^{a}$ | $993.92^{ab}$ | 40.12 |
| Dressing percentage (%) | $83.38^{c}$ | $89.54^{ab}$ | $94.39^{a}$ | $87.90^{bc}$ | 1.38 |
| Breast meat (g) | $133.32^{c}$ | $204.70^{b}$ | $226.00^{a}$ | $194.41^{c}$ | 10.40 |
| Drumstick (g) | $117.66^{c}$ | $127.10^{b}$ | $149.00^{a}$ | $119.20^{c}$ | 3.80 |
| Thigh (g) | 136.33 | 127.10 | 125.23 | 133.59 | 2.92 |
| Wing (g) | 119.00 | 116.70 | 112.10 | 94.14 | 2.95 |
| Fat pad (g) | 2.69 | 2.70 | 2.69 | 2.84 | 0.03 |

†Basal diet supplemented with lysine (g/kg DM) at 6 ($L_6$), 8 ($L_8$), 10 ($L_{10}$) and 12 ($L_{12}$).
[abc]Means in the row not sharing a common superscript are significantly different ($P<0.05$).

dietary lysine for minimal and maximal performance ranges between 11.8 and 12.2 g/kg DM feed in broiler chickens. Interestingly, it is important to note that the lysine levels reported by these authors are higher than those observed in the present study. This might be due to the breed used. Broiler chickens are fast growing and will, thus, require higher nutrients for their growth, similar observation was reported by Mack *et al*. (1999) in Isa and Ross broiler chickens. This might imply that indigenous chickens require less lysine than the broiler chickens.

Feed intake and growth rate of indigenous female Venda chickens aged 50 to 91 days were optimized at dietary lysine levels of 8.24 and 9.42, respectively (Table 5). Dietary lysine levels of 9.11, 9.89, 9.78 and 9.28 g/kg DM feed were required to optimize carcass weight, dressing percentage, breast meat and drumstick weights, respectively (Table 5). Results of Dozier *et al.* (2008) showed that using a broken line quadratic equation model, carcass weight and breast meat yield were optimized at dietary lysine levels of 9.2 and 9.7 g/kg DM feed, respectively. However, Han and Baker (1991) reported a higher dietary lysine level of 13.2 g/kg DM feed for optimal breast meat yield. The reason for differences in lysine level could be because of the strain of chickens used. Dozier *et al.* (2008) reported that modern broiler chickens grow faster per unit of feed intake and accretes more breast meat than commercial broiler chickens of the previous decade, which should translate into higher dietary lysine requirements.

Results of the effect of dietary lysine on haematological values of female Venda chickens aged 91 days are presented in Table 6. Dietary lysine had no effect ($P > 0.05$) on all the haematological parameters measured. The haematological parameters observed in the present study were within the range reported in literature for indigenous chickens (Elagib and Ahmed, 2011; Islam *et al.,* 2004).

Table 5. Dietary lysine levels (X) for optimal productivity and carcass characteristics of indigenous Venda chickens

| Trait | Formula | $r^2$ values | X | Y- value |
|---|---|---|---|---|
| *Starter (1–49d)* | | | | |
| Feed intake (g/d) | $Y = -14.00 + 10.86X - 0.56X^2$ | 0.727 | 9.70 | 38.65 |
| Growth rate (g/d) | $Y = -1.41 + 1.98X - 0.09X^2$ | 0.981 | 10.65 | 9.13 |
| *Grower (50–91d)* | | | | |
| Feed intake (g/d) | $Y = 53.01 + 8.08X - 0.49X^2$ | 0.580 | 8.24 | 86.32 |
| Growth rate (g/d) | $Y = -18.72 + 8.48X - 0.45X^2$ | 0.872 | 9.42 | 21.23 |
| Carcass weight (g) | $Y = -909.72 + 464.94X - 25.51X^2$ | 0.929 | 9.11 | 1208.8 |
| Dressing percentage (%) | $Y = 20.43 + 15.15X - 0.79X^2$ | 0.913 | 9.59 | 93.06 |
| Breast meat (g) | $Y = -391.56 + 126.08X - 6.44X^2$ | 0.922 | 9.79 | 225.53 |
| Drumstick (g) | $Y = -70.08 + 45.47X - 2.45X^2$ | 0.671 | 9.28 | 140.89 |

Table 6. Effect of lysine on haematological parameters of femal Venda chickens age 91d

| Variable | Dietary groups† | | | | SEM |
|---|---|---|---|---|---|
| | $L_6$ | $L_8$ | $L_{10}$ | $L_{12}$ | |
| WBC ($10^3$ $\mu$L) | 24.34 | 26.56 | 26.28 | 25.25 | 0.228 |
| RBC ($10^4$ $\mu$L) | 2.60 | 2.76 | 2.80 | 2.56 | 0.031 |
| Hb (g/dL) | 11.88 | 10.49 | 13.10 | 11.60 | 0.279 |
| PCV (%) | 33.68 | 35.87 | 36.73 | 40.20 | 0.716 |
| MCV (fl) | 138.67 | 136.90 | 139.18 | 142.33 | 1.101 |
| MCH (pg) | 45.48 | 49.60 | 47.87 | 45.98 | 0.492 |
| MCHC (g/dL) | 32.30 | 36.30 | 32.36 | 33.27 | 0.472 |

†Basal diet supplemented with lysine (g/kg DM) at 6 ($L_6$), 8 ($L_8$), 10 ($L_{10}$) and 12 ($L_{12}$).

WBC, white blood cell; RBC, red blood cell; MCV, mean corpuscular volume; MCH, mean corpuscular haemoglobin; MCHC, mean corpuscular haemoglobin concentration.

abcMeans in the row not sharing a common superscript are significantly different ($P<0.05$).

## CONCLUSION

The dietary lysine levels of 0.97 and 1.07% DM in chicken aged 1 to 49 days, and 0.82 and 0.94% DM in goower phase optimized feed intake and growth, respectively. Besides, the dietary lysine levels of 0.91 to 0.98% influenced carcass characteristics in Venda chickens. The present findings imply that accurate requirement estimates for lysine are critical in attempts to apply the ideal protein concept in formulating indigenous Venda chickens diets.

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