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Effect of Dietary Lysine to Energy Ratio on Performance of Unsexed Indigenous Venda Chickens

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ABSTRACT

Two experiments were conducted with the aim of determining the effect of dietary lysine to energy ratio on performance of unsexed indigenous Venda chickens raised in closed confinement from day-old up to 13 weeks old. In each experiment the diets were isocaloric and isonitrogenous but with different lysine to energy ratios. A complete randomized design was used in both experiments, the starter (1-6 weeks) and grower (7-13 weeks) experiments. The three starter diets, based on lysine to energy ratios, were T_0 (0.84), T_1 (1.04) and T_2 (1.23) g MJ^{-1} ME, while grower diets were T_3 (0.52), T_4 (0.71) and T_5 (0.89) g MJ^{-1} ME, respectively. A quadratic type equation was used to determine ratios for optimum growth, feed conversion ratio, breast meat yield and breast meat nitrogen content. The results indicate that at each phase different dietary lysine to energy ratios optimized both growth rate and feed conversion ratio. Dietary lysine to energy ratios of 1.20 and 1.17 g MJ^{-1} ME supported optimum growth rate and feed conversion ratio, respectively, during the starter period. Dietary lysine to energy ratios of 0.76 and 0.84 g MJ^{-1} ME supported optimum growth rate and breast meat nitrogen content during the grower phase. However, a single ratio of 0.81 g MJ^{-1} ME supported optimum breast meat yield and optimum feed conversion ratio. Dietary lysine to energy ratio had no effect on diet intake, digestibility and carcass weight. These findings have implications on ration formulation for indigenous Venda chickens.

Key words: Venda chickens, lysine to energy ratio, growth rate, feed conversion ratio, breast meat yield, breast meat nitrogen content

INTRODUCTION

Indigenous chickens are kept in many parts of the world irrespective of the climate, traditions, life standard, or religious taboos relating to consumption of eggs and chicken meat (Tadelle *et al.*, 2000). To the poor majority in rural areas, indigenous chickens serve as an immediate source of meat and income when money is needed for urgent family needs. In addition, it constitutes a significant contribution to human livelihood and food security (Swatson *et al.*, 2001). However, indigenous chickens are considered to be poor performers in terms of growth rate, feed conversion ratio, live weight and meat yield (Tadelle *et al.*, 2000). This implies that efforts are needed to improve their productivity potential.

One possible way of improving their productivity would be to formulate diets that could be set to a specific lysine to metabolisable energy ratio since dietary metabolisable energy is usually considered as a starting point for feed formulation, where all other nutrients especially protein and amino acids are set as a specific ratio to metabolisable energy (NRC, 1994). Although, presently, there is little or limited information on optimizing lysine to energy ratio as a nutritional approach for improving the productivity of indigenous chickens, it is envisaged that such procedure will help to simplify their feed formulation in situations where a greatly variable metabolisable energy content of diets are dictated, in addition to ensuring optimal performance in terms of growth rate, feed conversion ratio, live weight and high meat yield.

Perhaps, the most important trait in intensive indigenous chicken production is the efficient utilization of nutrients as feed cost is one of the major components of total cost of poultry production. According to Henrichs and Steinfeld (2007) feed alone contributes about 60 to 70% of the total cost of poultry production. Therefore, optimal utilization of feed and avoiding unnecessary feed wastage could be the leading factors in minimizing total cost of production. Such information would be very beneficial to rural poultry farmers in Limpopo province and elsewhere. The main objective of this study was, therefore, to determine dietary lysine to energy ratio for optimal productivity of unsexed indigenous Venda chickens raised in closed confinement from day-old up to 13 weeks of age.

MATERIALS AND METHODS

This study was conducted at the Experimental farm of the University of Limpopo in South Africa in August 2009. The first experiment was used to determine effect of dietary lysine to energy ratio on performance of unsexed indigenous Venda chickens between one and six weeks of age. At a day old, 180 unsexed Venda chicks were randomly assigned to three treatments with four replications, each having 15 birds. Thus, 12 floor pens (1.5 m^2 per pen) were used in total. A complete randomized design (SAS, 2008) was used. The experimental diets were isocaloric and isonitrogenous, but with different lysine to energy ratios (Table 1). The birds were offered feed and fresh water *ad libitum*. The daily lighting program was 24 h. The experiment was terminated when the birds were 6 weeks of age. The second experiment was used to determine the effect of dietary lysine to energy ratio on performance of unsexed Venda chickens between seven and 13 weeks of age. The design and layouts for the second experiment was similar to those in the first experiment, except that seven weeks old unsexed Venda chickens were randomly assigned to three treatments (Table 2) with four replications, each having 15 birds. Prior to this experiment, the chicks were fed a 220 g CP kg^{-1} DM practical diet that would satisfy their nutritional requirements according to the NRC (1994). The two experiments were carried out around the same time. The ambient temperature during the experimentation period ranged between 20 and 30°C.

The initial live weights of the birds were taken at the start of each experiment. Average live weight per bird was measured at weekly intervals by weighing the chickens in each pen and the

Table 1: Nutrient composition of the starter diets (Diets T_0 indicate lysine to energy ratio of (0.84 g MJ^{-1} ME), T_1 (1.04 g MJ^{-1} ME) and T_2 (1.23 g MJ^{-1} ME)

	Diet		
Nutrient	T_0	T_1	T_2
Dry matter (g kg^{-1})	931	931	931
Energy (MJ kg^{-1} DM feed)	12.97	12.97	12.97
Crude protein (g kg^{-1} DM)	220	220	220
Total lysine (g kg^{-1} DM)	11.0	13.5	16
Total lysine to energy ratio (g MJ^{-1} ME)	0.84	1.04	1.23

Table 2: Nutrient composition of the grower diets (Diets T_3 indicate lysine to energy ratio of (0.52 g MJ^{-1} ME), T_4 (0.71 g MJ^{-1} ME) and T_5 (0.89 g MJ^{-1} ME)

	Diet		
Nutrient	T_3	T_4	T_5
Dry matter (g kg^{-1})	928	928	928
Energy (MJ kg^{-1} DM feed)	13.38	13.38	13.38
Crude protein (g kg^{-1} DM)	220	220	220
Total lysine (g kg^{-1} DM)	7.0	9.5	12.0
Total lysine to energy ratio (g MJ^{-1} ME)	0.52	0.71	0.89

total live weight was divided by the total number of birds in the pen to get the average live weight of the chickens. These live weights were used to calculate growth rate. Feed conversion ratio per pen was calculated as total feed consumed divided by the weight of live birds plus the weight of birds in the pen at the start of the experiment. Digestibility was done between ages of 36 and 42 days and 85 and 91 days for experiment 1 and 2, respectively. Digestibility was conducted in specially designed metabolic cages with dimensions of 60×50 cm and a 1×1 cm wire mesh bottom having separated watering and feeding troughs. Four birds were randomly selected from each replicate and transferred to metabolic cages for the measurement of apparent digestibility. A three-day acclimatization period was allowed prior to a three-day collection period. Droppings voided by each bird were collected on a daily basis at 09.00 h. Care was taken to avoid contamination from feathers, scales, debris and feeds.

At 91 days of age all remaining Venda chickens per pen in experiment 2 were slaughtered. Breast meat yield and abdominal fat were weighed. Fat surrounding the gizzard and intestines extending to the bursa were considered as abdominal fat (Mendonca and Jensen, 1989). At the end of each slaughtering, meat samples from each breast part of the slaughtered bird were taken and stored in the refrigerator until analyzed for dry matter and nitrogen.

Dry matter and nitrogen contents of the diets, refusal, faeces and meat samples were determined as described by AOAC (2002). The gross energy of the diets and excreta samples was determined using an adiabatic bomb calorimeter (LATS University of Limpopo, South Africa). Lysine contents of the diets and meat samples were analyzed by ion-exchange chromatography (HPCL, University of Pretoria). The apparent Metabolisable Energy (ME) contents of the diets were calculated (AOAC, 2002). Apparent metabolisable energy was equal to energy in the feed consumed minus energy excreted in the faeces (AOAC, 2002). Nitrogen retention was calculated as intake nitrogen multiplied by digestibility nitrogen.

Data on feed intake, growth rate, feed conversion ratio, live weight, digestibility, carcass weight and carcass composition were analyzed by one-way analysis of variance (SAS, 2008). Where there was a significant F-test ($p<0.05$), the Least Significant Difference (LSD) method was used to separate the means (SAS, 2008). The dose-related responses in growth rate, feed conversion ratio, breast meat yield and breast meat nitrogen to dietary lysine to energy ratio were modeled using the following quadratic equation (SAS, 2008).

$$Y = a+b_{1X}+b_2x^2$$

where, Y is growth rate, feed conversion ratio, breast meat yield or breast meat nitrogen, a is intercept, b is coefficients of the quadratic equations, x is dietary lysine to energy ratio and $-b_1/2b_2$

is x value for optimum response. The quadratic model was fitted to the experimental data by means of the NLIN procedure of SAS (2008). The quadratic model was used because it gave us the best fit.

RESULTS

The range of ME levels used in the present study (12.97 and 13.38 MJ ME kg^{-1} DM) was selected to cover the practical levels of ME used in commercial broiler chicken starter and grower diets (Table 1, 2).

Results of the effects of dietary lysine to energy ratio on feed intake, growth rate, feed conversion ratio, nitrogen digestibility, diet ME and nitrogen retention of unsexed Venda chickens from 1 to 6 weeks of age are presented in Table 3, dietary lysine to energy ratio had no effect ($p>0.05$) on feed intake, nitrogen digestibility, diet ME and nitrogen retention of the chickens during this phase. Venda chickens offered dietary lysine to energy ratios of 1.04 (Diet T_1) and 1.23 (Diet T_2) had higher ($p<0.05$) growth rates than those offered dietary lysine to energy ratio of 0.84 (Diet T_0). However, there were no significant ($p>0.05$) differences in growth rates between Venda chickens on Diets T_1 and T_2. Venda chickens on Diet T_2 had a better ($p<0.05$) feed conversion ratio (1.89) than those on Diet T_0 (2.23).

Results of the effects of dietary lysine to energy ratio on feed intake, growth rate, feed conversion ratio, nitrogen digestibility, diet ME and nitrogen retention of unsexed Venda chickens from 7 to 13 weeks of age are presented in Table 4, dietary lysine to energy ratio had no effect ($p>0.05$) on feed intake, nitrogen digestibility, diet ME and nitrogen retention of the chickens.

Table 3: Effect of lysine to energy ratio on feed intake, growth rate, Feed Conversion Ratio (FCR), nitrogen digestibility, Metabolisable Energy (ME) and nitrogen retention of unsexed Venda chickens between one and six weeks of age (starter)

	Diet			
Parameters	T_0	T_1	T_2	SE
Feed intake (g DM/b/d)	33.7	33.7	34.1	1.164
Growth rate (g/b/d)	15.1^b	17.5^a	18.0^a	0.639
FCR	2.23^a	1.92^{ab}	1.89^b	0.091
N digestibility (decimal)	0.53	0.53	0.53	0.006
ME (MJ kg^{-1} DM)	11.5	11.60	11.50	0.043
N retention (g/bird/day)	1.40	1.41	1.30	0.066

Means in the same row not sharing a common superscript are significantly different ($p<0.05$). SE: Standard error

Table 4: Effect of lysine to energy ratio on feed intake, growth rate, feed conversion ratio (FCR), nitrogen digestibility, ME and nitrogen retention of unsexed Venda chickens from seven to13 weeks of age (grower stage)

	Diet			
Parameters	T_3	T_4	T_5	SE
Feed intake (g DM/b/d)	92.8	98.7	92.60	5.972
Growth rate (g/b/d)	19.2^b	24.0^a	22.85^a	2.149
FCR	4.83^a	4.11^{ab}	4.05^b	0.474
N digestibility (decimal)	0.60	0.61	0.59	0.009
ME (MJ/kg DM)	11.8	11.80	11.80	0.081
N retention (g/bird/day)	1.97	1.97	1.79	0.059

Means in the same row not sharing a common superscript are significantly different ($p<0.05$). SE: Standard error

Table 5: Effect of lysine to energy ratio on live weight, carcass weight, dressing percentage abdominal fat, breast meat yield and breast meat nitrogen of unsexed Venda chickens at 91 days of age

	Diet			
Parameters	T_3	T_4	T_5	SE
Live weight (g/bird)	1800	1874	1888	90.33
Carcass weight (g/bird)	1245	1304	1346	47.50
Dressing percentage (%)	66.8	69.4	71.7	2.233
Abdominal fat (g/bird)	22.5	20.0	18.5	4.300
Breast meat yield (g/bird)	233.2^b	301.2^a	304.2^a	16.90
Breast meat retention (g kg^{-1} DM)	25.3^b	29.5^{ab}	31.3^a	1.351

Means in the same row not sharing a common superscript are significantly different ($p<0.05$). SE: Standard error

Table 6: Dietary lysine to energy ratios for optimal growth rate, feed conversion ratio, breast meat yield and breast meat nitrogen content in unsexed Venda chickens during starter and grower growth phases

Trait	Formula	R^2	L: E ratio* (g MJ^{-1} ME)
1-6 weeks old			
Growth rate	$Y = -16.297+57.125x+-23.750x^2$	1.000	1.20
FCR	$Y = 6.671+ - 8.200x+3.500x^2$	1.000	1.17
7-13 weeks old			
Growth rate	$Y = -25.520+30.485x+ -85.546x^2$	1.000	0.76
FCR	$Y = 10.249+ -15.279x+9.341 x^2$	1.000	0.81
Breast meat yield	$Y =-302.384+1515.007x+-936.463x^2$	1.000	0.81
Breast meat N content	$Y = -3.817+80.816x+- 47.723x^2$	1.000	0.84

L: E ratio*: Optimal lysine to energy ratio

Venda chickens offered dietary lysine to energy ratios of 0.71 (Diet T_4) and 0.89 (Diet T_5) attained higher ($p<0.05$) growth rates than those offered dietary lysine to energy ratio of 0.52 (Diet T_3). Increasing dietary lysine to energy ratio from 0.52 (Diet T_3) to 0.89 (Diet T_5) improved ($p<0.05$) feed conversion ratio from 4.83 to 4.05, respectively.

Results of the effects of dietary lysine to energy ratio on live weight, carcass weight, dressing percentage, abdominal fat, breast meat yield and breast meat nitrogen content of unsexed Venda chickens at 91 days of age are shown in Table 5, dietary lysine to energy ratio had no effect ($p>0.05$) on live weight, carcass weight, dressing percentage and abdominal fat of the Venda chickens. Venda chickens offered dietary lysine to energy ratios of 0.71 (Diet T_4) and 0.89 (Diet T_5) had higher ($p<0.05$) breast meat yield than those offered dietary lysine to energy ratio of 0.52 (Diet T_3). Breast meat samples from Venda chickens offered Diet T_5 had higher ($p<0.05$) nitrogen content than those from chickens offered Diet T_3.

Growth rate and feed conversion ratio during the starter period were optimized at dietary lysine to energy ratios of 1.20 and 1.17 g MJ^{-1} ME, respectively (Table 6). During the grower period from seven to thirteen weeks of age, growth rate, feed conversion, breast meat yield and nitrogen content were optimized at dietary lysine to energy ratios of 0.76, 0.81, 0.81 and 0.84 g MJ^{-1} ME, respectively (Table 6).

DISCUSSION

The results of the present study indicate that during the starter and grower phases, dietary lysine to energy ratios of 1.20 and 0.76 g MJ^{-1} ME, respectively, optimized growth rate. These values are higher than the ratios of 0.89 and 0.75 g MJ^{-1} ME estimated for broiler chickens by the NRC (1984, 1994) for the starter and grower phases, respectively. Similarly, the ratio of 0.76 g MJ^{-1} ME is higher than 0.74 g MJ^{-1} ME found by Labadan *et al.* (2001) for broiler chickens between three and 6 weeks old. The present data indicates that dietary lysine to energy ratio for optimizing growth rate decreased as the chicken grew older. Kerr *et al.* (1999) and Labadan *et al.* (2001) found similar results with broiler chickens. However, Sibbald and Wolynetz (1990) estimated similar ratios in broiler chickens for the entire growth period.

Optimum dietary lysine to energy ratios of 1.17 and 0.81 g MJ^{-1} ME optimized feed conversion ratio during the starter and grower phases, respectively. The ratio of 1.17 during the starter phase is higher than the ratios of 1.05 g MJ^{-1} ME of Han and Baker (1991), 0.90 g MJ^{-1} ME of Labadan *et al.* (2001) and 0.99 g MJ^{-1} ME of Morris *et al.* (1987) estimated for optimum feed efficiency in broiler chickens during the starter phase. Similarly, the ratio of 0.81 g MJ^{-1} ME during the grower phase is higher than the 0.75 g MJ^{-1} ME of Labadan *et al.* (2001) estimated for optimum feed efficiency in broiler chickens during the grower phase but lower than the 0.89 g MJ^{-1} ME of Sinurat and Balnave (1985).

The present results indicate that dietary lysine to energy ratio for optimizing feed efficiency decreased with the age of the chickens. This is similar to the findings of Kerr *et al.* (1999) and Labadan *et al.* (2001). However, it is different from the findings of Sinurat and Balnave (1985) who observed similar requirements independent of the age in broiler chickens.

Results of the present study indicate that at each phase different dietary lysine to energy ratios optimized both growth rate and feed conversion ratio in unsexed Venda chickens. This is similar to the findings of Labadan *et al.* (2001) who observed different requirements of 0.95 and 0.74 g MJ^{-1} ME for optimum growth rate and 0.90 and 0.75 g MJ^{-1} ME for optimum feed efficiency during the 1-2 and 3-6 weeks old growth phases, respectively, in broiler chickens. However, results of Han and Baker (1991, 1994) and Morris *et al.* (1987) indicated that lysine requirements in chickens were generally higher for optimum feed efficiency than for growth. Their findings may imply that an alteration of tissues takes place, particularly muscle and fat deposits, which may differ in nutrient contents (Moran and Bilgili, 1990).

Dietary lysine to energy ratio of 0.81 g MJ^{-1} ME optimized breast meat during the grower phase. This is higher than the 0.74 g MJ^{-1} ME of Labadan *et al.* (2001). In the present study, dietary lysine to energy ratio of 0.84 g MJ^{-1} ME optimized breast meat nitrogen content during the grower phase. This ratio was higher than 0.81 g MJ^{-1} ME that optimized breast meat yield. No previous study on this issue was found in chickens.

Dietary lysine to energy ratio for optimum breast meat yield was similar to that for optimum feed conversion ratio but higher than that for optimum growth rate. This is similar to the results of Han and Baker (1994) who observed similar values for optimum breast meat yield and feed conversion ratio. However, these results are different from those of Labadan *et al.* (2001) which indicate similar values for optimum breast meat, growth rate and feed conversion ratio in broiler chickens during the grower phase.

In an isocaloric and isonitrogenous diet, increasing dietary lysine to energy ratio had no effect on diet intake, nitrogen digestibility, carcass weight, dressing percentage, abdominal fat, ME intake and nitrogen retention in unsexed Venda chickens. This is similar to the findings of Labadan *et al.* (2001). It is possible that the dietary lysine required for optimum feed intake, nitrogen digestibility, carcass weight, dressing percentage, abdominal fat, ME intake and nitrogen retention were lower than or equal to ratios used in the present study.

CONCLUSION

The range of dietary lysine to energy ratio used in this study did not have significant effect on diet intake, nitrogen digestibility, ME intake, nitrogen retention, carcass weight, abdominal fat content and dressing percentage of unsexed Venda chickens. However, during the starter phase, dietary lysine to energy ratio of 1.20 and 1.17g MJ^{-1} ME in a diet of 12.97 MJ and 220 g CP kg^{-1} DM, supported optimum growth rate and feed conversion ratio. On the other hand, dietary lysine to energy ratio of 0.81 g MJ^{-1} ME supported optimum feed conversion ratio and breast meat yield, respectively, while a higher ratio of 0.84 g MJ^{-1} ME supported optimum breast meat nitrogen content of unsexed Venda chickens during the grower phase. However, optimum growth rate required a slightly higher dietary lysine to energy ratio of 0.76 g MJ^{-1} ME than the ratio of 0.75 g MJ^{-1} ME determined by the NRC (1994) for broiler chickens during the grower phase. The possible explanation for higher dietary lysine to energy ratio levels for optimal growth rate in the present studies may be related to the differences in genotypes of the birds (Acar *et al.*, 1991; Han and Baker, 1991). These findings have a lot of implications on ration formulation for unsexed indigenous Venda chickens. However, more studies should be done to ascertain these responses.

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