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The Response of Male Indigenous Venda Chickens to Diet Energy to Protein Ratios Fed from Seven up to 13 Weeks of Age

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ABSTRACT An experiment was conducted with the objective of determining the response of male indigenous Venda chickens to varying energy to protein ratio fed from seven upto 13 weeks of age. The experimental design was completely randomized and a quadratic type equation was used to determine ratios for optimum production variables. The results indicate that a single dietary energy to protein ratio of 66 MJ ME/ kg protein supported optimum growth rate, live weight, carcass weight and fat pad weight. Dietary energy to protein ratios of 74, 65, 73, 71 and 62 MJ ME/ kg protein supported optimum feed intake, Feed feed conversion ratio, metabolisable energy intake, nitrogen retention and breast meat yield respectively., in indigenous male Venda. However, no single dietary energy to protein ratio optimized all the production variables under study. This may imply that the nutrient requirements of male indigenous Venda chickens are dependent on the particular production variable in question.

INTRODUCTION

Indigenous chickens contribute a lot to household nutrition and income in rural areas of the tropics (Swatson et al. 2001; Norris et al. 2007). One of such indigenous chickens in South Africa is the Venda chickens. The indigenous Venda chickens are multicoloured with white, black and red as the predominant colours (Mbajiorgu et al. 2011b). In contrast to exotic broiler chickens, little in terms of nutritional improvement is known about this indigenous breed which is presently being collected and evaluated (Mbajiorgu et al. 2011c). In this regard, determination of optimal dietary energy to protein ratio for maximizing production parameters and carcass characteristics of indigenous Venda chickens becomes very important. Furthermore, further processing of poultry to produce a variety of dismembered pieces of poultry products has placed more emphasis on meat yield, in addition to creating differences in management needs of different poultry producers. Perhaps, a practical feeding program should represent a compromise between the nutritional requirement of the animal and management needs, in order to balance poultry performance and economic yield. Hence, one One possible way of achieving this balance would be to formulate diets that could be set to a specific protein to metabolisable energy ratio since 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 protein to energy ratio as a nutritional approach for improving productivity of indigenous male Venda chickens, it is expected that such procedure will help to simply their feed formulation in addition to ensuring optimal performance in terms of feed intake, growth rate, feed conversion ratio, live weight and high meat yield. This will help to achieve the desired outcomes for different operations and hence enhance the economic, social and nutritional status of the rural farming households. The objective of this study was, therefore, to determine the response of male indigenous Venda chickens raised in closed confinement to varying energy to protein ratios fed from seven up to 13 weeks of age.

MATERIALS AND METHODS

Study Site

This study was conducted in August, 2009 at the University of Limpopo Experimental Farm at in Limpopo Province, South Africa.Syferkuil in August 2009. The farm is located at about 10 km northwest of the University of Limpopo Turfloop campus. The ambient temperatures around the study area ranged between 20 and 36 °C during summer and between 10 and 25 °C during the winter season.

Experimental Procedures, Dietary Treatments and Design

The study was conducted to determine the response of male indigenous Venda chickens to varying energy to protein ratios fed from seven up to 13 weeks of age. At seven weeks old, 100 male Venda chickens with an initial live weight of 320 ± 2 g per bird were randomly assigned to five treatments with four replications, each having 5 birds. Thus, 20 floor pens (1.5 m^2/pen) were used in total. The formulated experimental diets were purchased from Zet_B Feeds, Louis Trichardt, South Africa and were isocaloric, having similar energy level of 13.2 MJ ME/kg, but with five different levels of protein concentration of 220, 190, 180, 170 and 160 g/kg DM, thus ending up with different energy to protein ratios of 60,69, 73,78 and 83 MJ ME/kg protein, respectively and these were designated as diets V_1, V_2, V_3, V_4 and V_5 (Table 1). A completely randomized design was used for the experiment and the birds were offered feed and fresh water *ad libitum.* Prior to the experiment, the birds were fed a 22 % CP practical diets that would satisfy their nutritional requirements according to NRC (1994). The daily lighting program was 24 hours. The experiment was terminated when the birds were 13 weeks of age.

Table1: Dietary treatments for experiment

Diet	*Diet description*	*E:P ratio (MJ ME/ kg Protein)*
V_1	Diet containing13.2 MJ ME/kg DM feed and 220 g/kg crude protein	60
V_2	Diet containing13.2 MJ ME/kg DM feed and 190 g/kg crude protein	69
V_3	Diet containing13.2 MJ ME/kg DM feed and 180 g/kg crude protein	73
V_4	Diet containing13.2 MJ ME/kg DM feed and 170 g/kg crude protein	78
V_5	Diet containing13.2 MJ ME/kg DM feed and 160 g/kg crude protein	83

Data Collection

The initial Initial live weights of the birds were taken at the start of the experiment. Average live weight per bird was measured at weekly intervals by weighing the chickens in each pen, and the 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. Digestibility was conducted in specially designed metabolic cages with dimensions of 60x50cm and a 1x1cm 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 hours. Care was taken to avoid contamination from feathers, scales, debris and feeds. At 91 days of age, all remaining male Venda chickens per pen were slaughtered by cervical dislocation to determine carcass characteristics. Carcass parts and abdominal fat were weighed. Fat surrounding the gizzard and intestines extending to the bursa were considered as abdominal fat (Mendonca and Jenesen 1989). At the end of the slaughtering, breast Breast meat samples of the slaughtered birds were taken and analyzed for dry matter and nitrogen content as described by (AOAC 2002).

Nutrient Analysis

Dry matter and nitrogen contents of the diets, refusal and feces were determined. 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 were analyzed by ion-exchange chromatography (HPCL, University of Limpopo). The apparent metabolisable energy (ME) contents of the diets were calculated. Apparent metabolisable energy was equal to energy in the feed consumed minus energy excreted in the feces and all the analyses were done as described by (AOAC 2002). Nitrogen retention was calculated as intake nitrogen multiplied by digestibility nitrogen.

Data Analysis

Data were analyzed by one-way analysis of variance. Where there was a significant F-test ($P<0.05$), the least significant difference (LSD)

Table 2: Nutrient composition of the experimental diet

Nutrients	*Treatment*				
	$E_{13.2}P_{22}$	$E_{13.2}P_{19}$	$E_{13.2}P_{18}$	$E_{13.2}P_{17}$	$E_{13.2}P_{16}$
Dry matter(g/kg feed)	928.3	927.0	928.1	928.2	928
Energy (MJ/kgDM)	13.2	13.2	13.2	13.2	13.2
Protein (g/kg DM)	220	190	180	170	160
Lysine (g/kg DM)	10.8	11.5	10.5	11.0	11.3
E:P ratio (MJME/kg protein)	60	69	73	78	83
Calcium (g/kg DM)	10.7	10.2	10.3	10	10.4
Phosphorus (g/kg DM)	5.9	5.2	5.7	5.0	5.5

method was used to separate the means (SAS 2008). The dose-related responses in growth rate, feed conversion ratio or digestibility to dietary energy to protein ratio were modeled using the following quadratic equation:

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

Where Y = feed intake, growth rate, feed conversion ratio, live weight, ME, Nitrogen retention, carcass weight, breast meat yield, fat pad weight or digestibility; a = intercept; b = coefficients of the quadratic equations; x = dietary energy to protein ratio 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.

RESULTS

Results of the proximate analysis of the nutrient composition of the diets used in the experiment are presented in Table 2. The diets had a similar energy level of 13.2 MJ ME/kg DM but different protein levels, ranging between 220 and 160 g CP/kg DM.

Results of the effect of energy to protein ratio level on feed intake, feed dry matter digestibility, growth rate, feed conversion ratio, live weight, apparent metabolisable energy, nitrogen retention, carcass weight, breast meat yield and fat pad weight of male Venda chickens from seven to 13 weeks of age are presented in Table 3. Performance indices showed that there were no differences (P>0.05) in feed intakes between chickens offered diets having 60, 69, 73, 78 and 83 MJ ME/kg protein ratios. Male Venda Cchickens offered diets having 60 and 69 MJ ME/kg protein ratios had higher (P<0.05) growth rates than those offered a diet having 83 MJ ME/kg protein ratio. However, male Venda chickens offered diets having 60, 69, 73 and 78 MJ ME/kg protein ratios had similar (P>0.05) growth rates.

Venda chickens offered a diet having 69 MJ ME/kg protein ratio had higher (P<0.05) live weights than those offered a diet having 83 MJ ME/kg protein ratio. However, birds offered diets having 60, 69, 73 and 78 MJ ME/kg protein ratios had similar (P>0.05) live weights. Chickens offered a diet having 83 MJ ME/kg protein ratio had a poorer (P<0.05) feed conversion ra-

Table 3: Effect of differing dietary energy to protein ratios (MJ ME/kg protein) on production variables and carcass characteristics of male Venda chickens

Variable	*Treatment (E:P ratio)*					*SE*
	60	*69*	*73*	*78*	*83*	
Intake(g/bird)	74	81	86	79	82	4.55
Growth rate (g/bird)	13^{a}	13^{a}	12^{ab}	11^{ab}	8^{b}	1.53
FCR	5.7^{d}	6.2^{c}	7.2^{b}	7.2^{b}	10.2^{a}	1.12
Live weight (g/bird)	938^{ab}	970^{a}	920^{ab}	883^{ab}	705^{b}	75.06
ME (MJ ME/kgDM)	13.8	14.2	15.1	14.2	14.2	0.35
N-retention (g/bird)	2.5^{c}	2.6^{bc}	2.8^{a}	2.4^{c}	2.8^{a}	0.17
Carcass weight (g/bird)	805^{a}	824^{a}	789^{ab}	757^{ab}	564^{b}	73.57
Breast meat yield (g/bird)	153^{a}	142^{ab}	145^{ab}	131^{b}	112^{c}	12.55
Fat pad weight (g/bird)	1.6	1.2	1.7	2.6	2.0	1.56
DM Digestibility (%)	0.9	0.9	0.9	0.9	0.9	0.02

[abcde] Means in the same row not sharing a common superscript are significantly different (P<0.05).
SE: Standard error
DM Digestibility: Dry matter digestibility

tio than those on diets having 60, 69, 73 and 78 MJ ME/kg protein ratios. Male Venda chickens offered a diet having 60 MJ ME/kg protein ratio had a better ($P<0.05$) feed conversion ratio than those on diets having 69, 73, 78 and 83 MJ ME/kg protein ratios. However, Chickens offered diets having 73 and 78 MJ ME/kg protein ratios had the same ($P>0.05$) feed conversion ratios. There were no differences ($P>0.05$) in apparent metabolisable energy values between chickens offered diets having 60, 69, 73, 78 and 83 MJ ME/kg protein ratios. Male Venda chickens offered diets having 73 and 83 MJ ME/kg protein ratios had similar ($P>0.05$) nitrogen retention values but had higher ($P<0.05$) nitrogen retentions than those offered diets having 60, 69 and 78 MJ ME/kg protein ratios. Male Venda chickens offered diets having 60 and 69 MJ ME/kg protein ratios had higher ($P<0.05$) carcass weights than those offered a diet having 83 MJ ME/kg protein ratio. However, chickens offered diets having 60, 69, 73 and 78 MJ ME/kg protein ratios had similar ($P>0.05$) carcass weights. Male Venda chickens Chickens offered a diet having 60 MJ ME/kg protein ratio had higher ($P<0.05$) breast meat yields than those offered diets having 78 and 83 MJ ME/kg protein ratios. However, male Venda chickens offered diets having 60, 69 and 73 MJ ME/kg protein ratios had similar ($P>0.05$) breast meat yields. There were no differences ($P>0.05$) in fat pad weights and digestibility values between male Venda chickens offered diets having 60, 69, 73, 78 and 83 MJ ME/kg protein ratios.

Results of the effect of dietary energy to protein ratio level based on a dietary energy level of 13.2 MJ ME/kg DM on optimal feed intake, growth rate, feed conversion ratio, live weight, metabolisable energy, nitrogen retention, carcass weight, breast meat yield and fat pad weight in male Venda chickens between seven and 13 weeks old are presented in Table 4. Feed intake was optimized at a dietary energy to protein ratio of 74 MJ ME/kg protein. Growth rate, live weight, carcass weight, and fat pad weight were optimized at a single dietary energy to protein ratio of 66 MJ ME/kg proteins while FCR, ME, nitrogen retention and breast meat yield were optimized at dietary energy to protein ratios of 65, 73, 71 and 62 MJ ME/kg protein, respectively. However, quadratic analysis indicated no optimal digestibility response to dietary energy to protein ratios used in this experiment.

DISCUSSION

This experiment was designed to have high and low dietary energy to protein ratios. The experimental diets were isocaloric but with different levels of protein, thus ending up with different dietary energy to protein ratios ranging from 60 to 83 MJ ME/kg protein. The diets contained similar levels of other nutrients, which met the chicken's requirements as recommended by the NRC (1994) for broiler chickens.

Results of the present study indicate that dietary energy to protein ratio level had a significant effect on growth rate, feed conversion ratio, live weight, nitrogen retention, carcass weight and breast meat yield of male Venda chickens. Differences in performance variables are expected since it is known that alterations in dietary energy to protein ratio either by increasing or decreasing the ratio by means of changing the energy content, protein content or both will result in differences in animal performance (Buyse et al. 1992) and hence feeds of different dietary energy to protein ratios will give different performance responses. Similar results were obtained by Lin et al. (1980) and Jones and Smith (1986) who found that feed intake, growth rate, body weight gain, feed efficiency and live weight

Table 4: Effect of differing dietary energy to protein ratios (MJ ME/kg protein) on optimal production variables and carcass characteristics in male Venda chickens between seven and 13 weeks old

Trait	*Formula*	*E:P ratio*	*Y-Value*	*r^2*	*P*
Intake (g/bird/day)	$Y= -134.152 + 5.882x + -0.040x^2$	74	82	0.665	0.335
Growth (g/bird/day)	$Y= -81.385 + 2.866x + -0.022x^2$	66	13	0.994	0.006
FCR	$Y = 56.513 + -1.626x + 0.013x^2$	65	5.7	0.937	0.063
Live weight (g/bird)	$Y=-3743.921+144.411x+-.103x^2$	66	983	0.979	0.021
ME (MJ ME/kg DM),	$Y= -12.668 + 0.758x + -0.0053x^2$	73	14.4	0.544	0.456
N-retention (g/bird/day)	$Y= -10.054 + 0.370x + -0.0027x^2$	71	2.7	0.559	0.441
Carcass wt (g/bird)	$Y=-3904.105 +145.14x+-1.109x^2$	66	844	0.962	0.038
Breast weight (g/bird)	$Y=-201.085 +11.625x + -0.096x^2$	62	151	0.946	0.973
Fat pad (g/bird)	$Y = 26.488 + - 0.760x + 0.058x^2$	66	1.2	0.350	0.650

of meat-type broiler chickens change with alterations in dietary energy to protein ratio levels. However, these observations are contrary to the findings of Ndegwa et al. (2001) in Kenya who found no differences in performance variables of indigenous growing chickens when dietary energy to protein ratio of the feed was changed by increasing the diet crude protein content from 17 to 23 %.

In the present study, dietary energy to protein ratio level had no effect on apparent metabolisable energy values and fat pad weight in male Venda chickens. Thus, the absence of significant changes in these traits may indicate that the effect of diet was essentially the same on these traits. Thus, the non-significant differences observed for apparent metabolisable energy for the all the treatment groups could be traceable to the similar diet energy level used for the experiment which improved feed utilization and caused fat pad composition to remain constant irrespective of treatment. This may suggest that fat pad deposition in male indigenous Venda chickens is independent of dietary energy to protein ratio value of the diet. Contrary to the present findings, Bartov and Plavnik (1998) found that relative abdominal fat pad weight increased significantly in broiler chickens by increasing energy to protein ratio of the diet. Similarly, Leeson et al. (1996) showed that altering the dietary energy to protein ratio value increased fat deposition in broiler chickens. However, Leenstra (1986) suggested that the effect of diet on fat deposition vary with chicken strains. In addition, Marks (1990) showed that there is a significant genotype x diet interactions for percent abdominal fat deposition in chickens. Thus, one possible consequence of the intrinsic genetic limitations of indigenous chickens might be the inability to change their body fat composition according to alteration in dietary energy to protein ratio level. This might reflect the differences between indigenous and broiler chickens in terms of their genetic and physiological abilities to change their body fat composition according to changes in dietary energy to protein ratio value of the diet. In addition, it is also possible that the dietary energy to protein ratio level required for fat pad deposition and metabolisable energy intake were lower than or equal to ratios used in the present study. Thus, increasing the ratio level could not have any effect on fat pad deposition and metabolisable energy values.

Results of the present study indicate that a single dietary energy to protein ratio of 66 MJ ME/kg protein optimized growth rate, live weight, carcass weight and fat pad weight in male Venda chickens under this feed energy level. This is similar to the findings of NRC (1994) and Swatson et al. (2002a), who estimated single ratios of 58.17 and 61.12 MJ ME/kg protein, respectively, for all production variables in broiler chickens during the entire growth period. However, the optimum value of 66 MJ ME/kg protein observed in the present study are higher than the single ratios of 58.17 and 61.12 MJ ME/kg protein estimated by NRC (1994) and Swatson et al. (2002a), respectively, for broiler chickens during the entire growth period. The higher energy to protein ratios for optimum productivity in the present study may be indicative of lower protein requirements for indigenous male Venda chickens as compared to protein requirements for broiler chickens as similarly observed by Kingori et al. (2003). Thus, such discrepant variations in requirements may be due to genetic differences.

The ratio of 66 MJ ME/kg protein for optimizing growth rate, live weight, carcass weight and fat pad weight is higher than the ratios of 65 and 62 MJ ME/kg protein for optimum feed conversion ratio and breast meat yield but lower than the ratios of 74, 73 and 71 MJ ME/kg for optimum feed intake, metabolisable energy and nitrogen retention, respectively. This may imply that an alteration of tissues takes place, particularly muscle and fat deposits, which may differ in nutrient contents (Moran and Bilgili 1990). Thus, there seems to be no single dietary energy to protein ratio level for optimizing all the production variables under this study. Similar results were reported by Gonzalez and Pesti (1993) who evaluated the concept of an optimum dietary metabolisable energy to crude protein ratio in broiler chickens. Their data revealed that while there was no single optimum dietary metabolisable energy to crude protein ratio, optimal responses in production variables could best be predicted as quadratic functions of both metabolisable energy and crude protein levels. This implied that both nutrients affect productivity and as such, optimal dietary energy to protein ratios varied for all the production variables to meet the nutrient requirements of the chickens. Thus, energy and protein requirements of the chicken may influence the dietary energy to protein level for optimum production of a particular variable.

CONCLUSION

It can be concluded that not a single energy to protein ratio optimized feed intake, growth rate, live weight, feed conversion ratio, metabolisable energy and nitrogen retention in indigenous male Venda chickens between seven and 13 weeks of age. This is different from the findings of NRC (1994) who estimated a single dietary energy to protein ratio of 58.17 MJ ME/kg proteins for optimal productivity of all production variables in broiler chickens during the entire starter period. Thus, the variability in dietary energy to protein ratios for optimizing production parameters in the present study may imply that the nutrient requirements of indigenous male Venda chickens between seven and 13 weeks of age are dynamic and are dependant on the particular production variable in question. This should be taken into consideration when formulating rations for indigenous male Venda chickens. As such, the feeding program for indigenous male Venda chickens should consider the primary objective of the producer since the desired outcomes may differ for different operations. This has implications on ration formulation for indigenous male Venda chickens.

REFERENCES

AOAC 2002. *Official Methods of Analysis*. 17th Edition. Washington, DC: AOAC.

Bartov I, Plavnik I 1998. Moderate excess of dietary protein increases breast meat yield of broiler chicks. *Poultry Science*, 77: 680-688.

Buyse J, Decuypere E, Berghman L, Kuhn E R, Vandesande F 1992**.** The effect of dietary protein content on episodic growth hormone secretion and on heat production of male broilers. *British Poultry Science*, 33: 1101-1109.

Gonzalez MJ, Pesti GM 1993. Evaluation of the protein to energy ratio concept in broiler and turkey nutrition. *Poultry Science Journal*, 72: 2115-2123.

Jones R, Smith W K 1986. Effect of dietary protein concentration on the growth and carcass composition of male broiler from hatch to maturity. *British Poultry Science*, 27: 502-503.

Kingori AM, Tuitoek JK, Muiruri HK, Wachira AM 2003. Protein requirements of growing indigenous chickens during the 14-21 weeks growing period. *South African Journal of Animal Science*, 33: 78-82

Leeson S, Caston L, Summers JD 1996. Broiler response to diet energy. *Poultry Science Journal*, 75: 529-535.

Leenstra F R 1986. Effect of age, sex, genotype and environment on fat deposition in broiler chickens—A review. *World's Poultry Science Journal*, 42: 12-25.

Lin CY, Friars GW, Moran E T 1980. Genetic and environmental aspects of obesity in broilers. *World's Poultry Science Journal*, 36: 103-111

Marks HL 1990. Genotype by diet interactions in body and abdominal fat weight in broilers. *Poultry Science*, 69: 879-886.

Mbajiorgu CA, Ngambi JW, Norris D 2011b. Effect of varying dietary energy to protein ratio level on growth and productivity of indigenous Venda chickens. *Asian Journal of Animal and Veterinary Advances*, 6 (4): 344-352.

Mbajiorgu CA, Ngambi JW, Norris D, Alabi OJ 2011c. Effect of dietary lysine to energy to ratio on performance of unsexed indigenous Venda chickens. *Asian Journal of Animal and Veterinary Advances*, 6 (5): 517-524.

Mendoca CX, Jensen LS 1989. Influence of protein concentration on the sulphur containing amino acid requirement of broiler chickens. *British Poultry Science*, 30: 889-898. Doi: 10.1080/00071668908417215

Moran E T, Bilgili SF 1990. Processing losses, carcass quality and meat yield of broiler chickens receiving diets marginally deficient to adequate in lysine prior to marketing. *Poultry Science*, 69: 702-710.

Ndegwa JM, Mead R, Norrish P, Kimani CW, Wachira AM 2001**.** The performance of indigenous Kenya chickens fed diets containing different protein levels during rearing. *Tropical Animal Health Production*, (33): 441-448.

NRC1994. *Nutrient Requirements of Poultry*. 9th Revised Edition. National Academy of Science Press, Washington D.C.

Norris D, Ng'ambi JW, Benyi K, Makgahlela M L, Shemilis HA, Nesamvuni EA 2007. Analysis of growth curves of indigenous male Venda and naked neck chickens. *South African Journal of Animal Science*, 37(1): 21-26.

SAS 2008. *SAS User's Guide Version 9.2*. 2nd Edition. SAS Institute, Inc. Raleigh, North

Swatson HK, Gous R M, Iji P A, Zarrinkala R 2002a**.** *Proceedings of the 11th European Poultry Science Congress 6 to 10th August 2002. Bremen, Germany. Animal Research*, 51: 501-515.Caroline, USA.

Swatson HK, Nsahlai IV, Byebwa BK 2001. The status of smallholder poultry production in the Alfred District of KZN (South Africa): Priorities for intervention. *Proceedings of the Institutions for Tropical Veterinary Medicene, 10th International Conference on Livestock, Community and Environment*, 20-23rd August 2001, Copenhagen, Denmark.