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Effect of Energy/Protein Ratio and Strain on Performance, Nutrient Digestibility and Serum Biochemical Indices of Exotic and Locally Adapted Turkey

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Abstract

This study investigated the response of locally adapted and exotic turkeys raised under the same environmental conditions to diets with varying energy/protein ratio. One hundred and fourty-four (144) four-week old poults of each strain of turkey were randomly selected and assigned to six different diets in a 2 x 2 x 3 factorial arrangement. Each treatment diet were replicated twice with twelve (12) birds per replicate. Diets formulated with 28 %, 26 % and 24 % crude proteins levels were distributed to energy levels 2900 kcal/kg and 3000 (Kcal/Kg) with six energy/ protein (E/P) ratio 104:1, 112:1, 121:1, 107:1, 115:1, 125:1 respectively were fed to turkeys from 4 to 8 weeks. At 7th week of age, 2 birds per replicate were randomly selected and put in digestibility cages. Feacal samples collected from birds on daily basis for five days were weighed on wet and dry basis to determine the moisture and dry matter content. Body weight changes were recorded for the trial. The strain effect significantly (P<0.05) influenced the final body weight, daily weight gain, and daily feed intake in this trial. A significant strain x energy/protein interaction effect was observed on the final body weight. Energy/protein significantly (P<0.05) influenced the digestibility of crude fibre, ether extract, and ash. There was significant (P<0.05) effect of strains and E/P ratios on serum creatinine level. It is concluded that different energy protein ratios are required for optimum performance of exotic turkey (112:1) and locally adapted turkey (115:1) in the tropics.

Keywords: Locally adapted, exotic, serum, digestibility, energy/protein ratio, strain

INTRODUCTION

Differences in growth rate, carcass composition and part yield between and among strains of turkeys have been observed for many years [15, 28]. According to Veldkamp *et al.* (2002), most differences observed in turkey strains are in size and growth rate up to slaughter age [30]. The noted differences in rate of gain at different stages of growth and in carcass conformation in modern commercial strains of Large White turkeys has made some authors to suggest that the different strains may respond differently to nutrient levels [18, 36]. Various body functions such as maintenance, reproduction, egg production, milk, and meat production lead to distinct energy, protein, mineral, and vitamin requirements among different species, strains, or classes of animals [2, 34]. Nutrient requirements are influenced by two main types of factors: bird related factor, such as genetics, sex, type and stage of production; and external factors, such as environment, stress and husbandry conditions. Growing turkeys should have continuous access to feed and water. Differences has been identified in the growth rate of turkey species. Waldroup *et al.*, (1998) [32], reported that Nicholas White turkeys grew rapidly during

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starting phases, while BUT turkeys grew faster in the latter phases.

The dietary energy to protein ratio is an important index in poultry nutrition as it regulates productivity in term of growth performance and carcass quality [17, 19, 22, 33]. The specific ratio between dietary energy and crude protein is important for superior growth rate and carcass composition. The productivity of poultry was partly regulated by the energy/protein ratio of the diet and any limitation resulted in reduced growth and tissue accretion [31]. Tyagi (2001) suggested that turkey diet needed a narrower energy to protein ratio as compared to chicken diet [29].

Although possessing greater meat potential compared to chickens, indigenous turkeys remain the least produced among domesticated poultry species in Nigeria, with a population of approximately 1.05 million [3, 35]. Ngu *et al.*, (2014), reported that the production of most exotic poultry species is beyond the reach of most Nigerians [20].

Majority of global turkey meat originates from heavy hybrids reared under intensive systems of management. The rearing of turkeys under extensive system is also possible as demonstrated for BUT Big 6 by Platz *et al*. (2003) [23]. As per Thear and Fraser (1986), the Nigerian turkey market comprised approximately 60% of imported turkeys, with the remaining portion being sourced from other suppliers [27]. However, the Nigerian Local breed of turkey is fast gaining ground as source of meat and egg amongst several poultry farmers in Nigeria [21].

Feeding poultry varying amounts of dietary fiber has demonstrated an enhancement in the utilization of the majority of nutrients present in the provided feed [12]. Physiological factors such as age and species, along with pathological factors, can impact the composition of blood components [16, 26]. Conducting laboratory examinations of blood to assess its components is a crucial procedure that aids in diagnosing various diseases and dysfunctions. Blood analysis yields dependable results that can serve as valuable inputs for research studies focusing on nutrition, physiology, and pathology [8]. Kral and Suchý (2000) reported that serum biochemical parameters have been reported to provide valuable information on the immune status of animals [14]. Serum metabolites, including albumin, globulin, creatinine, and urea, serve as indicators of the adequacy of both the quality and quantity of protein in the diet. Bamgbose et al. (2007) observed increased total serum protein and serum albumin levels in exotic turkeys raised in Nigeria [6]. Additionally, Kokatnur et al. (2012) found a significant impact of the energy-to-protein (E/P) ratio on serum cholesterol levels [13].

MATERIALS AND METHODS

The experiment took place at the Turkey Unit of the Teaching and Research Farm located at Obafemi Awolowo University in Ile-Ife. Two hundred four four-week locally adapted and one hundred and fifty exotic turkey (Nicholas) poults were used for the study. Birds were brooded on floor pen using incandescent electricity bulb and burning charcoal in pots. One hundred and fourty-four (144) four-week old poults of each strain of turkey were randomly selected and assigned to six different diets in a 2 x 2 x 3 factorial arrangement. Each treatment diets were replicated twice with twelve (12) birds per replicate. The factors were two strains of turkey birds, two dietary metabolisable energy (ME) levels (2900 Kcal/Kg and 3000 Kcal/Kg) and three dietary crude protein (CP) levels (280 g/kg, 260 g/kg and 240 g/kg). The energy to protein (E/P) ratio of diets 1 to 6 were 104:1, 112:1, 121:1, 107:1, 115:1, 125:1 respectively. Diets used were produced at the Obafemi Awolowo University Teaching and Research Farm Feed Mill and were free of feed additives.

The experimental diets are outlined in Table 1. Unlimited access to clean drinking water and feed was provided ad libitum. Nutrient digestibility trial using standard procedure of total feacal collection method was carried at the 7^{th} week. Data on body weight changes and feed intake were recorded for five (5) days. Daily weight gain, daily feed intake, and feed conversion ratio (FCR) were computed. The proximate composition analysis of both the experimental diets and fecal samples was conducted following the methods outlined in AOAC (2002) [5].

Blood samples for serum study was obtained from two birds per treatment at the end of the trial. Blood was collected via wing vein using hypodermic needle and syringe into bottles without EDTA (ethylene diamine tetra acetic acid). Blood samples was centrifuged for 15min at 380hg and 4ºC to remove plasma. Samples were preserved at -22ºC until analyzed.

The model used for the effect of strain and energy-protein ratio is as specified below:

$Y_{ijk} = \mu + \alpha_i + \beta_j + \alpha\beta\gamma + e_{ijk}$

Where Y_{ijk} = Observed value per bird
μ = Overall mean
α_i = effect of strain
β_j = effect due to energy/protein ratio
$\alpha\beta_{ij}$ = interaction between strain and energy/protein ratio
e_{ijk} = Random error term

Data were subjected to Factorial Analysis of Variance (ANOVA) using the General Linear Model of SAS (2008) package for windows [25]. Significant differences between means were separated using the Duncan Mutiple Range Test.

Table 1. Gross composition of the Experimental diets of turkeys with varying energy/protein ratios (4-8 weeks).

Energy Level – ME (Kcal/Kg)		2900			3000	
Protein Level (%)	28	26	24	28	26	24
Experimental diets	1	2	3	4	5	6
Energy-Protein (E:P) ratio	104:1	112:1	121:1	107:1	115:1	125:1
Ingredients:						
Maize	38.75	42.24	47.90	43.01	48.11	51.54
Soy Bean Meal	47.22	41.00	34.60	48.63	42.40	36.10
Wheat Offal	7.00	9.68	10.73	1.01	2.40	5.09
Fish Meal	3.00	3.00	3.00	3.00	3.00	3.00
Palm Oil	1.00	1.00	0.50	1.32	1.00	1.00
Bone Meal	2.00	2.00	2.00	2.00	2.00	2.00
Premix	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.03	0.05	0.08	0.03	0.05	0.08
Lysine	-	0.03	0.19	-	0.04	0.19
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated Values						
ME (Kcal /Kg)	2902.32	2904.34	2905.54	3000.26	3007.58	3005.57
Crude Protein (%)	28.00	26.07	24.00	28.03	26.04	24.06
Ether Extract (%)	3.58	3.60	3.64	3.59	3.63	3.64
Crude fibre (%)	4.47	4.36	4.15	4.14	3.95	3.84
Methionine (%)	0.45	0.45	0.45	0.45	0.45	0.45
Lysine (%)	1.62	1.50	1.50	1.61	1.50	1.50
Calcium (%)	1.03	1.02	1.01	1.03	1.02	1.01
Phosphorus (%)	0.73	0.70	0.67	0.72	0.69	0.67

Premix composition to provide the following per kg of diet; vitamin A – 15,000.00,lu Vitamin D3 - 3, 000,000lu, Vitamin E-30,000,lu Vitamin K – 3,000mg Vitamin B1 3000,mg Vitamin B2 6000mg, Vitamin B6 5,000mg, Vitamin Bie 40mg, Biotin 200mg, Niacah-40,000mg, Pantothenic 15,000mg,Folic acid 2,000mg, choline 300,000mg,Iron 60,000mg, manganese 80,000mg, copper 25,000mg,Zinc 80,000mg cobalt 150mg, iodine 500mg, solencien 310mg, Antioxidant 20,000mg. Note – ME- Metabolisable energy

RESULTS AND DISCUSSION

Proximate composition of experimental diets are presented in Table 2. Proximate data obtained were similar to the calculated values obtained (Table 1).

Table 2. Proximate Composition of Turkey Diets with varying energy and protein levels (4-8 weeks of age) (%).

Treatments/Diets	1	2	3	4	5	6
Energy level (kcal/kg ME)	2900	2900	2900	3000	3000	3000
Protein level (%)	28	26	24	28	26	24
Energy/protein ratio	104:1	112:1	121:1	107:1	115:1	125:1
Dry matter (%)	89.20	90.23	88.90	90.50	90.34	89.96
Crude protein (%)	27.96	26.19	23.95	28.28	26.09	24.28
Crude fibre (%)	3.76	4.20	3.68	4.23	4.01	3.88
Ash (%)	9.13	9.60	7.44	7.47	7.62	6.66
Ether extract (%)	3.30	3.51	2.60	3.55	3.63	3.45
Nitrogen free extract (%)	45.05	46.73	51.23	47.00	48.99	51.69

Values are means of duplicate samples (air dried basis)

GROWTH PARAMETERS

Table 3 shows the effect of strain and energy-protein ratios on performance characteristics of locally adapted and exotic turkeys used for the digestibility trial. A significant (P<0.05) strain effect was observed in this trial, impacting the final body weight, daily weight gain, and daily feed intake. The FCR and percent weight gain were not significantly *(P>0.05)* influenced by strain, energy/protein ratio and strain x energy-protein interaction. A significant strain x energy-protein interaction effect was observed on the final body weight.

There were differences *(P<0.05)* in final body weight (g/bird) of locally adapted and exotic turkeys across all the energy-protein combinations (EP). This is in line with Yahaya *et al*, (2021) [34] that significant variations exits between the two strains of turkey studied and Damaziak *et al*, (2012) [9] who reported considerable differences in body weight gains and growth rate between fast-growing Big-6 hybrids and slow-growing Kelly Bronze turkeys. Exotic turkeys has higher *(P<0.05)* final body weight (g/bird), daily weight gain and daily feed intake (g/bird) across all energy–protein combinations. This shows a superior performance of exotic turkey over the locally adapted turkey, and this may be due to improved genetic potential and better adaptation of the exotic turkey to the environment. This findings agreed with the report of Zampiga *et al*, (2019) [36] that productive performance showed different growth profile between turkeys groups and Tumova *et al*, (2020) [28] who demonstrated differences in potential growth rate of male and female turkeys.

The findings in this study indicated that different energy protein ratios are required for optimum performance of exotic turkey (112:1) and locally adapted turkey (115:1) in the tropics. Thus, for the phase 4-8 weeks of age, energy/protein ratio 112:1 is suitable for raising exotic turkey while 115:1 is recommended for locally adapted turkey which translates the same crude protein level 26% at different metabolisable energy levels of 2900 and 3000 kcal/kg ME.

NUTRIENT DIGESTIBILITY PARAMETERS

Table 4 shows Nutrient digestibility parameters of locally adapted and exotic turkeys fed varying energy and protein levels. No significant (P>0.05) strain effect was observed for any of the examined nutrient digestibility coefficients. The dry matter digestibility was not significantly *(P>0.05)* influenced by any of experimental factors while there was significant *(P<0.05)* effect of energy/protein ratio on digestibility of crude fibre, ether extract, ash and ME. This agreed with the findings of Akinsuyi and Fatufe (2023) [4] who reported a significant effect of energy/lysine ratio on crude fibre digestibility in a similar study. There was significant *(P<0.05)* strain × energy-protein ratio interaction on ash digestibility. Dietary fiber exerts significant effects on the development of the gastrointestinal tract (GIT) and on various aspects of digestive physiology in poultry, including nutrient digestion, fermentation, and absorption processes (Jha and Mishra, 2021) [24]. The low crude fibre in the diets with E/P ratio 125:1(3.88) justifies this assertion as it has higher crude fibre digestibility values for the two strains of turkeys.

Locally adapted turkeys had higher digestibility values for crude protein, crude fibre, and Metabolisable energy on energy/protein ratio 125:1 and 104:1 than exotic turkey, while the ether extract was better utilized by exotic turkey on energy/protein ratio 115:1 and 107:1 and this could be responsible for the better growth rate of exotic turkey.

Table 3. Performance Characteristics of Locally Adapted and Exotic Turkey Digestibility Trial.

Parameter		E/P ratio	CP	Strain	Average Initial Weight (g/bird)	Average Final Weight (g/bird)	Daily Weight Gain (g/bird/d)	Daily Feed Intake (g/bird/d)	FCR	% Daily Weight Gain FW/bird
Energy – Protein Combination	E1P1	104:1	28	LO	736.67	946.67	42.00	62.53	1.50	22.18
				EX	1685.00	2180.00	99.00	127.00	1.29	22.70
	E1P2	112:1	26	LO	730.00	956.67	45.33	59.67	1.33	23.69
				EX	1285.00	1840.00	111.00	119.00	1.08	30.15
	E1P3	121:1	24	LO	676.67	860.00	36.67	54.87	1.77	20.28
				EX	1575.00	1990.00	83.00	113.00	1.39	20.78
	E2P1	107:1	28	LO	763.33	970.00	41.33	59.40	1.50	21.19
				EX	1335.00	1745.00	82.00	115.00	1.47	23.57
	E2P2	115:1	26	LO	713.33	973.33	52.00	59.60	1.16	27.00
				EX	1800.00	2140.00	68.00	112.00	1.72	15.74
	E2P3	125:1	24	LO	593.33	790.00	39.33	69.60	2.52	24.37
				EX	1610.00	2075.00	93.00	120.00	1.34	22.40
Mean Separation	Local				702.22[b]	916.11[b]	42.78[b]	60.94[b]	1.68	23.12
	Exotic				1548.33[a]	1995.00[a]	89.33[a]	117.67[a]	1.38	22.56
P- values	SEM				81.17	101.44	5.07	5.28	0.13	1.05
	Strain				<.0001	<.0001	<.0001	<.0001	0.3946	0.8056
	E:P				0.0013	0.0285	0.0389	0.0135	0.7838	0.6626
	S×E:P				0.0002	0.0026	0.2143	0.3461	0.6634	0.3641

Means within columns with different superscripts are significantly different (P < 0.05). EX – Exotic Turkey LO-Locally Adapted Turkey. E: P – Energy-Protein ratio, S – Strain, × - Interaction, E1P1 –E1P3 contained 2900 kcal/kg ME, while E2P1 –E2P3 contained 3000 kcal/kg ME, CP - crude protein, ME-metabolisable energy

Table 4. Nutrient digestibility of locally adapted and exotic turkeys fed varying energy and protein levels.

Parameter		E/P ratio	CP	Strain	Dry matter (%)	Crude Protein (%)	Crude Fibre (%)	Ether Extract (%)	Ash (%)	ME (%)
Energy – Protein Combination	E1P1	104:1	28	LO	90.80	89.12	78.24	88.65	79.19	96.97
				EX	90.14	85.91	78.40	88.49	80.47	96.74
	E1P2	112:1	26	LO	89.42	85.20	78.71	82.65	80.09	95.91
				EX	92.87	91.10	79.26	86.70	87.92	95.96
	E1P3	121:1	24	LO	90.49	83.24	82.52	80.38	83.28	95.00
				EX	90.71	79.36	80.61	79.17	83.14	95.05
	E2P1	107:1	28	LO	89.01	86.21	82.79	85.17	69.19	93.67
				EX	90.51	81.33	84.98	88.11	89.19	91.98
	E2P2	115:1	26	LO	89.95	87.65	79.45	88.59	71.89	94.26
				EX	92.44	88.69	80.45	90.64	64.52	95.40
	E2P3	125:1	24	LO	93.29	88.76	90.64	92.50	79.98	93.19
				EX	93.09	88.99	89.12	91.60	79.60	93.24
Mean Separation	Local				90.49	86.70	82.14	86.32	77.27	94.83
	Exotic				91.63	85.90	82.06	87.45	80.81	94.73
P- values	SEM				0.3910	0.8444	1.0119	1.0457	1.4921	0.2900
	Strain				0.1456	0.6182	0.9655	0.5517	0.1210	0.7154
	E:P				0.2004	0.0704	0.0130	0.0208	0.0075	<.0001
	S×E:P				0.5701	0.4011	0.9837	0.9447	0.0333	0.1880

Means within columns with different superscripts are significantly different (P < 0.05). EX – Exotic Turkey LO-Locally Adapted Turkey. E: P – Energy-Protein ratio, S – Strain, × - Interaction. E1P1 –E1P3 contained 2900 kcal/kg ME, while E2P1 –E2P3 contained 3000 kcal/kg ME, CP - crude protein, ME-metabolisable energy.

SERUM BIOCHEMICAL INDICES

Serum Biochemical Indices of Locally Adapted and Exotic Turkeys Fed Varying Energy and Protein Levels are shown in Table 5. There was significant *(P<0.05)* effect of strains and E/P ratios on the blood creatinine (mg/dl) level. The non-significant *(P>0.05)* strain effect on all blood serum indices except creatinine across treatments in this present study was against the significant effect of breed earlier reported for turkeys (Isidahomen *et al.*, 2013) [11].

Serum creatinine (mg/dl) level was significantly *(P<0.05)* higher for exotic turkeys on 121:1 while locally adapted turkeys recorded higher serum creatinine (mg/dl) on 112:1, 107:1 and 115:1 respectively. Locally adapted turkeys recorded higher serum urea (g/dl) on all dietary treatments except on 104:1 and 112:1. Exotic turkeys recorded significantly *(P<0.05)* higher total serum protein (g/dl), albumin (g/dl) and globulin (g/dl) on 112:1. Total serum protein (g/dl) values ranged 5.59 – 12.96 (g/dl) and 5.59 – 19.09 (g/dl) recorded for locally adapted and exotic turkeys respectively in this study is within the 6.57 – 7.53g/dl reported for turkeys (Afolayan *et al.*, 2014) [1] but higher than the range 3.6 – 5.5g/dl reported for juvenile wild turkeys [8], 3.30 - 4.70g/dl reported for juvenile turkeys at 148 days of age [7] and 3.60 – 3.90 g/dl reported for local turkey poults fed two varieties of sorghum [10].

Table 5. Serum Biochemical Indices of Locally Adapted and Exotic Turkeys Fed Varying Energy and Protein Levels.

Parameter		E/P ratio	CP	Strain	Creatinine (mg/dl)	Urea (g/dl)	Total Protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)
Energy – Protein Combination	E1P1	104:1	28	LO	0.53	7.32	12.96	0.79	12.17
				EX	1.33	8.75	6.19	1.34	4.84
	E1P2	112:1	26	LO	2.41	4.49	7.45^{b}	1.34	6.11^{b}
				EX	0.46	12.09	12.07^{a}	0.87	11.20^{a}
	E1P3	121:1	24	LO	1.47^{b}	9.44	9.18	0.99	8.19
				EX	3.24^{a}	2.21	19.09	0.79	18.29
	E2P1	107:1	28	LO	0.24	8.56	12.24	0.9	11.34
				EX	0.21	4.05	11.35	1.18	10.17
	E2P2	115:1	26	LO	1.91	8.12	8.19	1.13	7.06
				EX	0.40	4.69	6.4	1.49	4.91
	E2P3	125:1	24	LO	0.77	5.18	5.59	0.93	4.66
				EX	2.19	4.68	5.59	0.98	4.62
	Local				1.22	7.18	9.27	1.01	8.26
	Exotic				1.30	6.07	10.12	1.11	9.01
	E:P1				0.85^{ab}	7.89	3.68	10.25	1.01
	E:P2				1.63^{ab}	7.53	3.52	9.3	1.15
	E:P3				2.18^{a}	6.55	3.06	13.14	0.91
	E:P4				0.23^{b}	6.75	3.15	11.89	1.01
	E:P5				1.31^{ab}	6.75	3.15	7.48	1.27
	E:P6				1.34^{ab}	4.98	2.33	5.59	0.95
P- values	SEM				0.2322	0.9448	1.1997	0.0712	1.2019
	Strain				0.8462	0.6063	0.7453	0.5337	0.7702
	E:P				0.1307	0.9332	0.4761	0.6982	0.4377
	S×E:P				0.0812	0.4318	0.5418	0.4246	0.4675

Means within columns with different superscripts are significantly different (P < 0.05). LO – Locally Adapted Turkey EX – Exotic Turkey. E – Energy, P – Protein, E: P – Energy/Protein ratio, S – Strain, × - Interaction. E1P1 –E1P3 contained 2900 kcal/kg ME, while E2P1 –E2P3 contained 3000 kcal/kg ME, CP - crude protein,

Serum albumin, globulin, urea, and creatinine serve as indicators to assess the adequacy or inadequacy of protein in terms of both its quality and quantity within the diet. The significantly higher serum total protein of exotic turkey suggest inefficient utilization of protein in the diet. The significantly *(P<0.05)* higher serum creatinine (mg/dl) on E/P 121:1 is an indication of high muscle wasting and it impacted the weight of exotic and locally adapted turkey.

CORRELATION COEFFICIENTS

The correlation coefficients of Energy/protein ratio with serum metabolites of turkey strains are shown in Table 6. Energy/protein ratio has negative correlation *(P>0.05)* with local turkey serum urea, total protein and serum globulin and, positive correlation with serum creatinine and albumin. There was negative correlation *(P>0.05)* of exotic turkey serum albumin with energy-protein ratios. However, there was significant *(P<0.05)* positive correlation of energy/protein ratios with exotic turkey serum creatinine (0.6384). A significant *(P<0.05)* positive correlation exist between Serum Total Protein (g/dl) and Serum Globulin (g/dl) of locally adapted turkey (0.9976) and exotic turkey (0.9976) respectively. Total serum protein may be used as an indirect measurement of dietary protein quality and utilization.

Table 6. Pearson Correlation coefficient of dietary energy, protein and energy-protein ratio with locally adapted (above diagonal) and exotic (below diagonal) turkey serum biochemical indices.

	Energy/Protein ratio	**Serum Creatinine (mg/dl)**	**Serum Urea (g/dl)**	**Serum Total Protein (g/dl)**	**Serum Albumin (g/dl)**	**Serum Globulin (g/dl)**
Energy-Protein ratio	1	0.1620	-0.0446	-0.3810	0.0814	-0.3864
Serum Creatinine (mg/dl)	0.6384*		-0.1654	-0.0258	0.3801	-0.0520
Serum Urea (g/dl)	-0.3172	-0.3680		-0.1162	0.0423	-0.1190
Serum Total Protein (g/dl)	0.1373	0.1783	0.0680		0.0248	0.9976*
Serum Albumin (g/dl)	-0.3754	-0.2693	0.0334	-0.0504		-0.0442
Serum Globulin (g/dl)	0.1551	0.1908	0.0661	0.9988*	-0.0939	

**- Significant at the 0.05 level.*

CONCLUSION

The results concluded that of exotic turkey and locally adapted turkey (115:1) required diets with different energy/protein ratio; 112:1 and 115:1 respectively or optimum growth performance in the. This indicated that the same crude protein level (26%) at different metabolisable energy levels of 2900 kcal/kg ME and 3000 kcal/kg ME respectively could be recommended as suitable for raising exotic and locally adapted turkeys in the tropics from 4-8 weeks of age.

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