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AMINO ACID REQUIREMENTS OF GROWING RABBITS IN HOT CLIMATES 1. PREDICTION OF QUANTITATIVE NEEDS

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SUMMARY - Ninty NZW rabbits of both sexes, weaned at 5 weeks, of age were fed on nine completely pelleted isocaloric diets (2700 Kcal/K_1) using 0.420, 0.0525 and 0.630% dietary Sulphur amino acids (SAA) at 14% crude protein (CP), 0.480, 0.600 and 0.720% SAA at 16% CP and 0.540, 0.675 and 0.810 SAA at 18% CP respectively during the growing period (5-11 weeks of age). This work was designed to investigate the optimal levels of SAA for growing NZW rabbits in hot climates under different CP% levels. Growth and feed intake were measured over 6 weeks. Carcass characteristics and economic evaluation were also carried out at the termination of the study. Twelve regression equations were drawn for the prediction of the maximal response to 3 dietary protein levels and 9 levels of SAA in the tested diets in case of body weight (BW) and sixteen equations were also obtained in case of feed conversion (FC). Results indicated that BW at 7, 9 and 11 weeks were affected significantly (P<0.01 & P<0.05) by levels of dietary CP and SAA. Body weight values of NZW rabbits at these periods were higher in high protein groups (18% CP) than those at lower ones (16 & 14% CP). The maximal requirements of dietary SAA for growing NZW rabbits was 0.600% at 16% CP. It is worthly noting that increasing dietary SAA content above 0.60% did not cause any further significant increase in body weight. Average FC during the experimental periods were more efficient in high protein groups (16% & 18%) than those receiving the lowest one (14% CP), showing similar trend to those of the body weight. Therefore,from nutritional and economical point of view, the present data suggest that there would be an advantage for using 16% CP diet with 0.600% SAA and 0.330% M. during the growing period of NZW rabbits (5-11 weeks, of age) under hot climates. The next preferable one was the 18% CP diet with 0.675% SAA and 0.375% M. The nutrition of rabbits is the most important factor affecting the productivity of rabbits. However, protein and total sulphur amino acid requirements of growing rabbits have been studied by several investigators. Diets containing 16-20% CP may provide adequate nutrients for optimum performance of growing purchased NZW (Deshumukh and Pathak 1991), while the NRC, 1977 recommended 16% CP and 0.600% total sulphur amino acids. Taboada et al. (1995) found that a minimum level of 0.54% of total sulphur-containing amino acid (0.40% of digestible sulphur-containing aa) was required to obtain adequate productivity in remating rabbits and growing rabbits, while a higher level (0.62% of TSAA) fermitted a 6 to 8% increase in the milk production, reduced the interval between parturitions, and improved feed utilization efficiency. The objective of this experiment was to determine the effect of different levels of dietary protein and total sulphur amino acids on the growth performance and feed efficiency. The experimental design allowed to draw regression equations for the prediction of the maximal response to dietary protein levels and 9 levels of SAA in case of body weight (BW) and feed conversion (FC).

Key words : Crude protien, Methionine, Sulphur, amino acids .

MATERIALS AND METHODS

Ninty NZW rabbits of both sexes, weaned at 5 week, of age were divided randomly into 3 treatment groups, each of 30 rabbits, nearly equal in live weight. Rabbits in each treatment group were distributed into three sub-treatments with 10 rabbits in each. Three isocaloric diets (2700 Kcal DE/kg) of three different levels of dietary protein (14, 16 and 18%) were formulated as basal diets with the NRC (1977) recommendation of Methionine and TSAA for growing rabbits. Three graded levels of M and TSAA within each level of dietary protein were formulated as follows:

The first three isocaloric diets of 14% CP had 0.180, 0.285 and .390% M and 0.420, 0.525 and 0.630% TSAA. The second three ones of 16% CP had 0.210, 0.330 & 0.450 M, and 0.480, 0.600 and

0.720% TSAA, and the third three isocaloric diets had 0.240, .370 & 0.510% M and 0.540, 0.675 and 0.810% TSAA, respectively. All the nine dietary pelleted diets were isocaloric.

Management

Animals were housed in individual cages with feeder and automatic watering system and were kept under the same managerial conditions. Feed and water were provided ad-lib., rabbits were individually weighed at 5 (weaning age), 9 and 11 week old and feed conversion (g feed/g gain) were estimated duringthe growing period (5-11 weeks of age).

Statistical Analysis

Data were analyzed by ANOVA using the General Linear Models Procedure of SAS soft ware (SAS Institute, 1986). when significant ($P < 0.05$) differences were obtained, Duncan's new multiple range test (1955) was used to separate means.

Twelve regression equations were drawn for the prediction of maximal response to 3 dietary protein levels and 9 levels of SAA in the tested diets in case of body weight (BW) and sixteen equations were also obtained in case of feed conversion (FC).

RESULTS AND DISCUSSION

I. Comparison of observed and calculated values of BW

The observed and calculated values of BW as affected by CP and SAA levels, during the experimental periods are presented in Table (2). The statistical analysis are shown in Table (3).

The initial live body weight of NZW rabbit weaned at five weeks of age was nearly similar ranging from 677$\pm$25 to 680$\pm$29 g. The observed body weight at 7, 9 and 11 weeks were affected significantly ($P < 0.01$), ($P<0.05$) by levels of dietary CP and SAA. Body weight values of NZW rabbits at 7, 9, and 11 weeks were higher in high protein groups (18.12%) than those at lower ones (16 or 14% CP) as shown in Table (2). Maximum growth during the different experi-mental periods was obtained with the NRC SAA.

It is worthy noting that decreasing or increasing SAA levels than that of NRC recommendation are not preferable. As far as growth rate is concerned, low and medium protein diets are definitely deficient in SAA, but high protein diet (18.12%) with 0.675% SAA (0.375 M + 0.300 Cys) seem to be adequate during the first period (5-7 week), while medium protein diet (16.02%) with 0.600% SAA (0.330 Meth. + 0.270 Cys.) seem to be adequate for the medium (7-9 weeks) and late (9-11 weeks) periods.

Rabbits fed on rations containing low or medium protein levels (14.11 & 16.02%) during the first experimental period (5-7 weeks) and containing 0.525 or 0.600% SAA recorded 1 and 6.8% lower body weights than those fed a ration containing 18.12% CP with 0.675% SAA. During the medium period (7-9 weeks) rabbit fed on ration containing 16.02% CP with 0.600% SAA recorded 5.5% higher than those fed ration with 14.11% CP and 0.630% SAA. The same effect of this ration prolonged to the last experimental period (9-11 weeks) recording 6.3% higher than those fed on low content of both CP and SAA.

When the previous requirements for the low protein diets, medium and high protein diets are expressed as percentage methionine per CP or kilocalory (therm) of DE per Kg diet, the respective values for growth become 2.070 or 0.137 percent during the first (5-7 weeks) followed by 2.060 or 0.121 percent during the medium and last periods (Table 3). The corresponding percentages per SAA were 3.73 or 0.246 and 3.750 or 0.221 per CP and kilocalory (therm) of DE per Kg diet.

Ayyat (1991) recommends 0.240 percent SAA per therm (DE) Kg diet having 16.4% CP and 0.349 percent SAA per therm (DE) per Kg diet having 14.35% CP.

Omol (1982) suggested that the range between 18 and 22% CP could be optimal for growing rabbit, under tropical conditions, while Spreadbury (1978) reported that about 16% CP was the optimal level in a temperate Climate.

Adamson and fisher, (1973) observed that the best estimate of the quantitative requirement of SAA (Meth. + Cys) as percentage of the diet was 0.6% and added that the calculated values for BW were comparable to each other.

Regression equations:

Twelve regression equations were drawn for the predication of the maximal response to 3 dietary protein levels and 9 levels of SAA in the tested diets as follows:

A. When X_2 was expressed as Meth.% of diet.

$Y_1 = 873.689 + 13.692\ X_1 - 20.232\ X_2$ (7 Wks).

$Y_2 = 1069.169 + 24.684\ X_1 + 100.741X_2$ (9 Wks).

$Y_3 = 1459.006 + 22.763\ X_1 + 193.288\ X_2$ (11 Wks).

B. When X_2 was expressed as M% of dietary CP levels.

$Y_1 = 875.850 + 13.248\ X_1 - 0.826\ X_2$ (7 Wks).

$Y_2 = 1029.073 + 26.710\ X_1 + 19.856\ X_2$ (9 Wks).

$Y_3 = 1394.969 + 26.739X_1 + 30.171X_2$ (11 Wks).

C. When X_2 was expressed as SAA% of diet.

$Y_1 = 847.287 + 13.972\ X_1 - 19.628\ X_2$ (7 Wks).

$Y_2 = 1066.203 + 23.132\ X_1 + 101.808X_2$ (9 Wks).

$Y_3 = 1453.299 + 19.861\ X_1 + 193.602X_2$ (11 Wks).

D. When X_2 was expressed as SAA % of dietary CP levels.

$Y_1 = 876.613 + 13.239X_1 - 0.622\ X_2$ (7 Wks).

$Y_2 = 991.857 + 26.908X_1 + 20.030X_2$ (9 Wks).

$Y_3 = 1336.655 + 27.050X_1 + 31.414X_2$ (11 Wks).

Where :

Y_1, Y_2, Y_3 are average BW at 7, 9 and 11 weeks in each case, respectively.

X_1 is crude protein

II. Comparison of observed and calculated values of FC

The observed and calculated values of (FC) as affectd by CP and SAA levels during the experimental period are presented in Table (2) and statistical analysis are shown in Table 3.

The average FC during the epxerimental period; (5-7), (7-9), (9-11) and (5-11) weeks were affected significantly (P<0.01) by levels of dietary CP and SAA as shown in Table (2). FC values of NZW rabbits during the experimental period (5-7), (7-9), (9-11) and (5-11) weeks were more efficient in high protein groups (16 & 18%) than those receiving the lowest one (14%). Showing similar trend to those of the body weight.

Decreasing the SAA-20% than those of NRC level decreased the FC of NZW rabbits during the experimental periods.

Maximum FC during the different experimental periods were obtained with the NRC SAA levels as shown in Table 2.

During the first (5-7 weeks) and second (7-9 weeks) experimental periods rabbits utilize the high protein diets (18.12%) more efficiency than the other ones showing that it is definitely sufficient in both protein and SAA as shown in Table (2).

Rabbits which were fed on 14% during the first experimental period (5-7 weeks) or 16% CP diets recorded 8.6% and 1.3%, respectively lower than that of more efficiently diet (18.12% CP), and the same rations recorded 12.7% and 2.1%, respectively lower than that of hgih protein (18.12%).

During the last experimental period (9-11 weeks), the more efficiently diet (18.12%) recorded 8.9 and 0.9%, respectively, lower than that of 14% or 16% CP.

Therefore the requirement for optimum feed conversion was found to be 0.375% Methionine and 0.675% SAA with the high CP diet (18.12%) but from statistical and nutritional point of view 16.02% CP diet with not more than the NRC SAA level (0.330% Meth. & 0.600% SAA) was adequate. Supplementation of ration to achieve the recommended requirements for sulphur amino acids has been reported to increase growth rate and improve feed conversion efficiency (Colin and Arkhrust, 1975, Prudhon et al., 1977, Colin 1978 and Spreadbury (1978). Zajkowska et al., (1980) found that diets for rabbits supplemented with Methionine or lysine or both improved feed conversion, while Tag El-Din (1984) stated that feed covnersion efficiency was not affected by protein level or Methionine and/or lysine supplementation.

Observed and calculated values for FC were comparable to each other. The calculated values were also closely comparable to earlier.

Regression equations

Sixteen regression equations were drawn for the predication of the maximal response to 3 dietary protein levels and 9 levels of SAA in the tested diets using the previous model as follows:

A. When X_2 was expressed as Meth. % of diet.

$Y_1 = 3.399 - 0.053\ X_1 - 0.392\ X_2$ (5-7 Wks).
$Y_2 = 4.674 - 0.093\ X_1 - 0.364\ X_2$ (7-9 Wks).
$Y_3 = 5.529 - 0.099\ X_1 - 0.871 X_2$ (9-11 Wks).
$Y_4 = 4.663 - 0.091 X_1 - 0.485 X_2$ (5-11Wks).

B. When X_2 was expressed as Meth. % of dietary CP levels.

$Y_1 = 3.535 - 0.062 X_1 - 0.066\ X_2$ (5-7 Wks).
$Y_2 = 4.808 - 0.100\ X_1 - 0.066\ X_2$ (7-9 Wks).
$Y_3 = 5.825 - 0.116\ X_1 - 0.144\ X_2$ (9-11 Wks).
$Y_4 = 4.838 - 0.101\ X_1 - 0.086 X_2$ (5-11Wks).

C. When X_2 was expressed as SAA% of diet.

$Y_1 = 3.411 - 0.047\ X_1 - 0.396 X_2$ (5-7 Wks).
$Y_2 = 4.684 - 0.087\ X_1 - 0.367 X_2$ (7-9 Wks).
$Y_3 = 5.555 - 0.085\ X_1 - 0.873 X_2$ (9-11 Wks).
$Y_4 = 4.677 - 0.084\ X_1 - 0.489\ X_2$ (5-11Wks).

D. When X_2 was expressed as SAA% of dietary CP levels

$Y_1 = 3.658 - 0.062\ X_1 - 0.067\ X_2$ (5-7 Wks).
$Y_2 = 4.931 - 0.101 X_1 - 0.067\ X_2$ (7-9 Wks).
$Y_3 = 6.094 - 0.117 X_1 - 0.145 X_2$ (9-11 Wks).
$Y_4 = 5.000 - 0.102 X_1 - 0.087\ X_2$ (5-11Wks).

where :
Y_1, Y_2, Y_3 and Y_4 are the feed conversion (FC) at (5-7), (7-9) and (9-11) weeks in each case, respectively. X_1 is crude protein.

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Table (1) : Composition and chemical analysis of basal diets and the nine tested isocaloric diets.

Items	Basal Diet No.								
	A			B			C		
Alfalfa Meal	30.00			30.00			30.00		
Wheat Bran	37.00			37.00			37.00		
Barley	24.50			19.00			13.50		
Soybean Meal (44%)	5.50			11.00			16.50		
Molasses	1.50			1.50			1.50		
Lime Stone	0.95			0.95			0.95		
Salt	0.30			0.30			0.30		
Vit & Min premix *	0.25			0.25			0.25		
Total	100			100			100		
Chemical Analysis (as fed)									
CP %	14.11			16.02			18.12		
EE%	2.75			2.69			2.63		
CF%	12.82			12.87			12.92		
NFE%	54.12			52.12			49.76		
Ash %	8.52			8.43			8.38		
Meth.%**	0.18			0.21			0.24		
Cys. % **	0.24			0.27			0.30		
TSAA % **	0.42			0.48			0.54		
DE Kcal/Kg**	2694			2718			2742		
Tested Diet No.	NRC-20%	NRC	NRC +20%	NRC-20%	NRC	NRC +20%	NRC-20%	NRC	NRC +20%
Met. (% of Diet)	0.180	0.285	0.39	0.210	0.330	0.45	0.240	0.375	0.51
Met. (% of CP)	1.28	2.02	2.79	1.31	2.06	2.81	1.32	2.07	2.81
SAA (% of Diet)	0.420	0.525	0.63	0.480	0.600	0.720	0.540	0.675	0.81
SAA (% of CP)	2.98	3.72	4.46	3.00	3.75	4.49	2.98	3.73	4.47
DE (% of Diet)	269.4	269.4	369.4	271.8	271.8	271.8	274.2	274.2	274.2
DE (% of CP)	19.04	19.09	19.09	16.97	16.97	16.97	15.13	15.13	15.13

* Vitamins and minerals premix per kg contains.
Vit. A 2000000 IU; VIT.D 150000 IU; Vit. E 8.33 g; Vit. K0.33g; B1 0.33g; Vit. B2 lg; Vit. 86 0.33g; Vit. B9 8.33g; Vit. B12 1.7 mg; Pantothenic acid 3.33g; Biotin 33 mg; Folic acid 0.83g; Choline Chloride 200g; Zn 11.7g ; Fe 12.5g; Cu 0.5g; I 33. 3mg; Se 16.6 mg; and Mn Sq.
** Calculated according to NRC for rabbits (1977).

Table (2): Comparison of observed (O) and Calculated (C) values of Body weight and feed conversion (FC) for growing NZW rabbits fed different levels of Cpand SAA.

Tr. No.	CP	Nutrient levels % Meth. of diet	% Meth. of CP	% SSA of diet	% SSA of CP	Body weight (BW) BW5 Initial (g) Mean±SE	BW7 O Mean±SE	BW7 C Mean	BW9 O Mean±SE	BW9 C Mean	BW11 O Mean±SE	BW11 C Mean	Feed Conversion (FC) (5-7) weeks O Mean±SE	(5-7) weeks C Mean	(7-9) weeks O Mean±SE	(7-9) weeks C Mean	(9-11) weeks O Mean±SE	(9-11) weeks C Mean	(5-11) weeks O Mean±SE	(5-11) weeks C Mean
Low protein groups :																				
1	14.11	0.180	1.276	0.420	2.98	680±49	1024 b ± 59	1063	1394±67	1435	1819±72	1815	2.69a±0.017	2.58	3.40a±0.13	3.30	4.13a±0.18	3.99	3.46±0.11	3.29
2	14.11	0.285	2.020	0.525	3.72	681±53	1092ab±59	1061	1418±80	1445	1855±79	1835	2.45bcd±0.03	2.54	3.24b±0.09	3.26	3.69b±0.20	3.90	3.13±0.10	3.24
3	14.11	0.390	2.764	0.630	4.46	678±54	1048b±71	1059	1483±95	1458	1821±96	1856	2.58ab±0.05	2.50	3.25b±0.10	3.23	3.95a±0.15	3.81	3.24±0.09	3.18
		Mean				680±29	1055±36B		1432±46B		1832±47B		2.57±0.04A		3.30±0.06A		3.92±0.10A		3.28±0.06B	
Medium protein groups:																				
4	16.02	0.210	1.311	0.480	2.99	680±45	1054b±75	1089	1490±103	1486	1798±98	1864	2.44bc±0.07	2.47	3.18±0.10	3.11	3.92a±0.28	3.77	3.13±0.11	3.10
5	16.02	0.330	2.060	0.600	3.75	681±48	1158a±67	1086	1564±80	1498	1971±88	1888	2.27de±0.07	2.42	2.89cd±0.10	3.07	3.39cd±0.20	3.67	2.82±0.10	3.04
6	16.02	0.450	2.809	0.720	4.49	669±44	1084ab±64	1084	1522±77	1510	1914±84	1911	2.30cde±0.06	2.37	2.96c±0.11	3.03	3.57bc±0.20	3.56	2.94±0.10	2.98
		Mean				667±25	1099±89AB	1086	1525±48A		1894±55AB		2.38±0.04B		3.01±0.06B		3.60±0.13B		2.96±0.06A	
High protein groups :																				
7	18.12	0.240	1.325	0.540	2.98	679±44	1109ab±40	1117	1545±42	1540	1924±51	1918	2.38cde±0.04	2.35	2.88cd±0.09	2.91	3.55bc±0.12	3.54	2.91±0.10	2.89
8	18.12	0.375	2.070	0.675	3.73	682±48	1166±35	1114	1567±47	1554	1954±56	1944	2.24e±0.06	2.29	2.83d±0.08	2.86	3.36d±0.18	3.43	2.74±0.10	2.82
9	18.12	0.510	2.815	0.810	4.47	680±48	1050b±71	1112	1511±96	1568	1944±96	1970	2.34cdeb±0.05	2.24	2.96cd±0.10	2.81	3.44cd±0.20	3.31	2.94±0.12	2.76
		Mean				680±26	1108±80A		1541±86A		1941±47AB		2.32±0.03B		2.89±0.05C		3.43±0.11c		2.86±0.06C	

Overall means in the same column, bearing different capital letters, differed significantly.
Means in the same column, with different small letters, bearing different significantly.

Table (3) : Methionine and Total SAA Requirements of Growing NZW Rabbits Expressed in Different Ways and ANOVA of Effect of dietary CP and SAA levels on Growth performance and feed utilization.

Exp. Period (week)	Maximum BW (9)	Maximum improv. FC	Methionine Rquirements				Total SAA requirements				S.O.V.	DF	Mean Squares		
			% of Diet	% of CP	% /K cal DE/kg diet	mg M/g Gain	% of Diet	% of CP	% /K cal DE/Kg diet	mg SAA/g Gai			BW	FI	FC
													5 weeks		
	1092ab	2.45bcd	0.285	2.020	0.106	7.00	0.525	3.75	0.195	12.89	CP	2	108.58NS	33.56NS	0.754**
5-7	1158a	2.27cd	0.330	2.060	0.121	7.49	0.600	3.75	0.221	13.47	SAA(CP)	6	178.19NS	384.66**	0.106**
	1166a	2.24	0.375	2.070	0.137	8.40	0.675	3.73	0.246	15.12	R	9	190307.95	269.25	0.093
											Error	72	1709.29	113.59	0.026
													7 weeks		
	1483	3.24b	0.390	2.764	0.145	12.68	0.630	4.46	0.234	20.48	CP	2	24658.98*	54.24**	1.204**
7-9	1564	2.89cd	0.330	2.060	0.121	9.52	0.600	3.75	0.221	17.32	SAA(CP)	6	24871.84**	916.40**	0.124**
	1567	2.83d	0.375	2.070	0.137	10.61	0.675	3.73	0.246	19.09	R	9	282552.97	532.10	0.703
											Error	68	4755.07	132.10	0.021
													9 weeks		
	1855	3.69b	0.285	2.020	0.106	10.51	0.525	3.72	0.195	19.37	CP	2	101492.58NS	2016.77**	1.605**
9-11	1971	3.39cd	0.330	2.060	0.121	11.19	0.600	3.75	0.221	20.35	SAA(CP)	6	13974.37NS	1051.65**	0.442**
	1954	3.36d	0.375	2.070	0.137	12.38	0.675	3.73	0.246	22.28	R	9	382552.97	1648.00	0.287
											Error	66	16251.24	124.06	0.047
													11 weeks		
	1855	3.13c	0.285	2.020	0.106	8.92	0.525	3.72	0.195	16.43	CP	2	83350.93*	122.77NS	1.191**
5-11	1971	2.82ef	0.330	2.060	0.121	9.31	0.600	3.75	0.221	16.93	SAA(CP)	6	26130.48NS	58.52NS	0.200**
	1954	2.74f	0.375	2.070	0.137	10.53	0.675	3.73	0.246	18.53	R	9	463426.84	446.07	0.756
											Error	66	21505.33	65.08	0.014

Means in the same column with different small letters, bearing different significantly.
NS=Non significant.
* Signficiant at (P < 0.05).
** Significant at (P < 0.01).