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SULPHUR AMINO ACID REQUIREMENT FOR MAXIMUM GROWTH OF BROILER CHICKS IN INDONESIA

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Abstract

This experiment was designed to estimate the sulphur amino acids (SAA) requirement of broiler chicken diets using an endogenous feedstuff. One hundred and seventy five day old unsexed broiler chicks were used in this experiment and set on 3 experiment factor design consisted of elevations (0 and 600 m above the sea level), seasons (rainy, dry and intermediate), and breeds (Arbor Acres and Hubbard). Two periods of experiment were carried out to estimate the requirement of SAA at starter (0 – 21 d) and finisher (22 – 42 d) periods. SAA were used at level of 0.51 %, 0.63 %, 0.75 %, 0.87 %, 0.99 % and 0.52 %, 0.575 %, 0.63 %, 0.685 %, 0.74 % at starter and finisher periods, respectively. Experiment diets contained 15 % crude protein and metabolism energy 2900 kcal/kg and 3200 kcal/kg at starter and finisher periods. Data of growth rate were used to determine the curve response reached plateau. Data of growth rate were analysed by regression non linear asymptotic. Exponential response curve were fitted to experiment data points using the following equations: $Y = A + B (1 - EXP^{-C(X - D)})$ used SPSS for Windows to calculate parametric approach and Microsoft Excel program to calculate value of X on Y 95 % maximum. The result of this experiment indicated that the effect of elevations and seasons were highly significant ($P<0.01$), but the effect of breed was not significant. Interactions between the experiment factors and level of SAA was significant ($P<0.05$). The requirement of SAA on elevation 0 m above the sea level was estimated 0.90 % and 0.73 %, 600 m above the sea level 0.91 % and 0.71 %, dry seasons 0.89 % and 0.67 %, intermediate seasons 0.90% and 0.71 %, rainy seasons 0.88 % and 0.71 %, breed Arbor Acres and Hubbard 0.90 % and 0.68 % at starter and finisher period, respectively. Based on pooling using means of growth rate, the result of this experiment indicated that the requirement of SAA level for maximum growth was estimated 0.87 % and 0.72 % based from exponential response curve $Y = 282 + 68 (1 - EXP^{-6.86(X - 0.27)})$ and $Y = 900 + 80 (1 - EXP^{-3.74(X - 0.29)})$ at starter and finisher periods, respectively. Requirement SAA in subtropical countries was 0.74% and 0.66 %, so this requirement 0.13 % and 0.06 % higher than sub tropical recommendation at starter and finisher periods, respectively. Based on this experiment indicated that broiler chicken in Indonesia need higher amino acids for maximum growth.

Key words: Broiler chicks, Sulphur amino acid requirement, Growth, Exponential response curve.

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Introduction

Biotechnology has had an important influence on the nutrition of poultry, and developments within genetic engineering and fermentation methods will probably increase this action. Biotechnology will play an important role in developing products, which can increase the utilization of nutrient in feed to the advantage of the poultry and to the benefit of the environment. This will probably also be the case with cultures of microorganism. Some amino acids are produced by bacterial cultures in fermentation, and the yield may be increased by selecting for higher yielding strains (Fris Jensen, 1997).

Sulphur amino acids (methionine and cystine) are the first limiting amino acids in practical type poultry diets. Thus, there is little question that a tremendous demand exists for methionine, whether from DL Methionine or from DL Methionine hydroxy analog. There is considerable room for continued expansion of methionine usage in poultry diets. Over 90 % of the methionine and lysine products are used in animal feed applications and poultry account for majority of this volume. Thus, recent work shows that methionine and lysine are the critical limiting amino acids in lower diets protein diets for broiler chicks.

The requirement of amino acids in Indonesia is based on the recommendation from National Research Council (NRC) USA, Alimentary Equilibrium Commentary (AEC) Franch and other researcher from sub tropical countries. Climate and feed ingredient in subtropical countries were different from Indonesia (tropical country). Differences in factors environment caused the recommendation requirement of amino acids ca not be adopted in Indonesia directly. Heat stress caused hypothesis that requirement amino acids in Indonesia higher than subtropical countries. This experiment was designed to estimate sulphur amino acids requirement of broiler chicks used a usual ingredient feed stuff in Indonesia.

Materials and Methods

Bioassay

One hundred and seventy five unsex day old broiler chicks were used in this experiment. They were housed in 7 unit litter collective cages (0.5 m x 1 m) and treated on different experimental factor. The experimental factor consisted of elevations (0 m and 600 m) above the sea level, seasons (rainy, dry and intermediate), and strains (Arbor Acres and Hubbard). Energy diets were used in this experiment using an endogenous Indonesian feedstuff.

The basal diets were used a usual ingredient feed stuff available in Indonesia. Basal diet using in this experiment can be seen in Table 1. Macro nutritional content of basal diets and amino acids content of basal diets can be seen in Table 2 and 3.

Basal diet composition similar with practical diet used in several Indonesia feed mill. Feed and water were consumed *ad libitum.*

Chemical analysis

Crude fibre, crude protein, fat, ash contents of diets were analysed using methods described by the Association of Official Analytical Chemists (AOAC, 1980).

Amino acids content of diets were measured using an auto analyser Hitachi 835 after 24-h acid hydrolysis with 6 M aqueous HCl at 115°C. Methionine and cystine were determined on samples oxidized with performic acid (Moore, 1963).

Statistical analysis

The result of the experiment were analysed by means of ANOVA as randomised block design. The computer program SPSS/PC was used to calculate the ANOVA. The treatment factors were dietary level of SAA and experiment factors. Five level of SAA consisted 0.51 %, 0.63 %, 0.75 %, 0.87 %, 0.99 % and 0.52 %, 0.575 %, 0.63 %, 0.685%, 0.74 % at starter and finisher diets, respectively. Seven experiment factors consisted elevations (0 and 600 m above the sea), seasons (dry, intermediate and rainy), and breeds (Abror Acres and Hubbard).

Table 1. Composition of the basal diets

Feed ingredient	Starter Period (%)	Finisher Period (%)
Yellow corn	55.578	61.667
Rice bran	13.916	13.798
Soybean meal	9.277	9.198
Fish meal	4.177	5.463
Crude palm oil	2.783	5.519
Wheat pollard	7.229	0.526
Filler *)	4.676	1.876
$CaCO_3$	1.248	1.112
Dicalcium phosphate	0.236	0.273
L Lysine HCl	0.426	0.233
Treonine	0.196	0.099
NaCl	0.093	0.092
Vitamin-mineral Premix	0.093	0.092
Triptophane	0.060	0.040
Anticoccidiastat	0.012	0.012
Total	100.00	100.00

*) On filler fill in DL Methionine as well as experimental treatment.

Table 2. Nutritional content of experimental diets

Nutritional Content	Formulated at Starter Diet	Formulated at Finisher Diet	Analysis at Starter Diet	Analysis at Finisher Diet
Crude protein (%)	15,04	15,00	14,75	15,38
Fat (%)	7,83	10,90	10,90	16,80
Crude Fibre (%)	4,01	3,61	4,80	4,10
Ash (%)	5,58	5,54	5,72	3,56
Gross Energy (Kcal/kg)			4219	4021
Gross Energy Excreta (Kcal/kg)			3863	4676
Metabolism Energy (Kcal/kg)	2900	3250	2994	3055

Table 3. Amino acids content experimental diets

Amino acids (%)	Formulated at starter diet	Formulated at finisher diet	Analysis at starter diet	Analysis at finisher diet
Arginine	0.51	0.51	0.69	0.70
Glysine	0.53	0.55	0.56	0.66
Histidine	0.33	0.33		
Isoleusine	0.45	0.47	0.36	0.38
Leusine	1.22	1.27	1.12	1.18
Lysine	1.12	0.94	0.95	0.87
Methionine	0.27	0.29	0.36	0.40
Meth-systine	0.51	0.52	0.62	0.64
Phenilalanine	0.59	0.61	0.49	0.60
Treonine	0.73	0.64	0.73	0.59
Triptophane	0.21	0.19		
Valine	0.61	0.64	0.49	0.50
Aspartate			1.13	1.22
Serine			0.62	0.66
Glutamate			2.21	2.17
Proline			0.82	0.82
Alanine			0.74	0.84
Total amino acid			11.89	12.23

The SAA requirements were estimate from growth rate a non-regression procedure. Exponential response curves were fitted to the experimental data points using following equation: $Y = A + B\ (1 - EXP^{-C(X-D)})$

Y = growth rate of chicks
A = intercept
B = maximum improvement from added DL Methionine
C = curvature stepness
X = SAA level, experimental diets (percentage)
D = SAA level, basal diet (percentage)

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Results and Discussion

Data of growth rate of broiler chicken at the starter period was in the Table 4 and at finisher see in Table 5. The result of this experiment indicated that experimental factors highly significant (P<0.01) at starter and finisher periods. The effect of SAA level at starter period highly significant (P<0.01), but at finisher period ono significant. Interactions the experimental factor and level of SAA at starter period highly significant (P<0.01) and at finisher period significant (P<0.05).

Table 4. Data of growth rate at starter period (gram)

Factor	Item	Level of SAA (%)				
		0.51	0.63	0.75	0.87	0.99
Elevations	0 above sea level (asl)	282	343	388	343	351
	600 above sea level (asl)	252	274	255	260	268
Seasons	Dry	252	330	402	406	407
	Intermediate	205	281	319	292	264
	Rainy	336	356	405	349	346
Breed	Abror Acres	271	316	262	372	320
	Hubbard	276	386	376	308	338
	Means	282	327	344	333	328

Table 5. Data of growth rate at finisher period (gram)

Factor	Item	Level of SAA (%)				
		0.52	0.575	0.63	0.685	0.74
Elevations	0 above sea level (asl)	823	788	948	739	774
	600 above sea level (asl)	774	876	766	690	884
Seasons	Dry	904	861	1000	935	1042
	Intermediate	1083	1107	1093	1045	1000
	Rainy	1112	1094	1209	1089	1138
Breed	Abror Acres	764	828	848	978	968
	Hubbard	902	1147	1061	870	544
	Means	909	957	989	906	907

The grand means of growth rate at starter period (Table 4) was improved up dietary SAA of 0.75 % and than decreased. At finisher period (Table 5), the grand means of growth rate was improved up dietary SAA up 0.63 %.

The exponential equation for experimental factors and summary of estimated SAA requirement see in Table 6 at starter period and Table 7 at finisher period.

A summary of the SAA requirement estimated for exponential response curves is presented in Table 6. Based on this analysis the estimated SAA requirement for obtaining maximum growth rate have a little different on differences experimental factors, range 0.88 % to 0.91 %. Based on the pooling using means of growth rate (standard), the result of this experiment indicated that the requirement of SAA estimated 0.87 % at starter period.

At finisher period, the range of estimated requirement on different experimental factors 0.67 % to 0.73 %. Based on pooling using means growth rate, the estimated of SAA requirement 0.72 %.

Data of growth rate this experiment have variation among experimental factor of elevations, seasons and breeds. The standard of requirement calculating from the value of grand mean all experimental factors. Exponential equation at starter period: $Y = 282 + 68\ (1 - EXP^{(-6.86\ X - 0.27)})$, value of Y 95 % max: 349.3053 gram and requirement of SAA estimated 0.87 %. At finisher period, the exponential equation: $Y = 900 + 80\ (1 - EXP^{(-3.74X - 0.92)})$, value of Y 95 % max : 970.5453 and requirement of SAA estimated 0.72 %.

Recommendation of SAA requirement from subtropical countries (Table 8) indicated in Indonesia need SAA higher than they recommendation, but not to comparable with recommendation of RPAN at finisher period.

Schutte and Pack (1995) state that the requirement of broiler chicks for methionine and total sulphur amino acids during early live (0 to 2 or 3 wk) is well established, but in Indonesia broiler chicks at starter period need SAA higher than their recommendation about 0.13 % and at finisher period 0.06 %. Increasing requirement at starter diet higher than finisher diet. This fact indication that broiler chicks in Indonesia need SAA during early live higher.

Table 6. Summary of the estimated SAA requirement from exponential response curves at starter period

Experimental Factors	Exponential Equations $Y = A + B\ (1 - EXP^{-C(X-D)})$	Value of Y 95% maximum	Requirement of Methionine (X on Y 95% Max)	SAA
Elevations				
0 m asl	$Y=282+104(1-EXP^{(-1.286X-0.27)})$	352.0620	0.66	0.90
600 m asl	$Y=252+22(1-EXP^{(-0.686X-0.27)})$	263.3620	0.67	0.91
Seasons				
Dry	$Y=252+155(1-EXP^{(-1.98\ X-0.27)})$	373.7890	0.65	0.89
Intermediate	$Y=205+114(1-EXP^{(-1.37\ X-0.27)})$	283.7200	0.66	0.90
Rainy	$Y=336+69\ (1-EXP^{(-0.25\ X-0.27)})$	360.0658	0.64	0.88
Breeds				
Abror Acres	$Y=271+101(1-EXP^{(-0.51\ X-0.27)})$	316.9848	0.66	0.90
Hubbard	$Y=276+110(1-EXP^{(-1.11\ X-0.27)})$	345.8018	0.66	0.90
Pooling using Means	$Y=282+68\ (1-EXP^{(-6.86\ X-0.27)})$	349.3053	0.63	0.87

All animals are in a dynamic relationship with their environment (Freeman, 1988). The environmental factors that will be considered are: temperature, relative humidity, air movement, air quality, altitude, light and sound. The environmental factors in Indonesia are different than sub tropical countries, especially temperature.

Table 7. Summary of estimated SAA requirement from exponential response curves at finisher period.

Experimental Factors	Exponential Equations $Y = A + B(1 - EXP^{-C(X-D)})$	Value of Y 95% maximum	Requirement of Methionine (X on Y 95% Max)	SAA
Elevations				
0 m asl	$Y=739+209(1-EXP^{(-0.32X-0.29)})$	814.6771	0.50	0.73
600 m asl	$Y=749+110(1-EXP^{(-0.713X-0.29)})$	800.3939	0.48	0.71
Seasons				
Dry	$Y=904+138(1-EXP^{(-0.45X-0.29)})$	957.0093	0.44	0.67
Intermediate	$Y=1000+107(1-EXP^{(-1.51X-0.29)})$	1068.3000	0.48	0.71
Rainy	$Y=1048+97(1-EXP^{(-3.71X-0.29)})$	1132.9000	0.48	0.71
Breeds				
Abror Acres	$Y=764+214(1-EXP^{(-1.34X-0.29)})$	890.4940	0.45	0.68
Hubbard	$Y=764+214(1-EXP^{(-1.75X-0.29)})$	904.9862	0.45	0.68
Pooling using means	Y=900+80 (1-EXP(-3.74 X-0.29))	970.5453	0.49	0.72

Table 8. Recommendation of Requirement SAA from Subtropical Countries (%)

Period	NRC (1994)	RPAN (1993)	AEC (1987)	Heartland Lysine (1995)
Starter	0.76	0.75	0.74	0.74
Finisher	0.67	0.75	0.65	0.66

Chicks are homeoterms; some develop homeothermy (to a greater or lesser degree) at hatching and are described as precocious, others, the altricial species develop the mechanism sometime after hatching (Misson, 1977). The mature deep body temperatures of chicks are generally higher than those of mammals. Mature values for chicken 41 – 42°C. Under most practical conditions, therefore, heat will flow from the chicks to the environment by radiation, convection and conduction. The relative importance of these routes will vary with the conditions.

It is known that basal metabolic rate is higher in the fowl in winter than in summer (Tasaki and Sakurai, 1969) and that this is probably a result of changes in thyroid activity (Freeman, 1988). As temperature raises so food intake declines. It has been variously calculated that reduction, for chicks, is in the range 1.1 to 1.6 % per degree Celsius (Emmans, 1974). The over riding factor determining the quantity of food consumed seems to be the energy requirement of the chicks. In meeting the reduced requirement of energy chicks which has access only to a compounded diet is likely to receive less than the maintenance requirement for certain nutrients such as amino acid or vitamins. These deficiencies usually become manifest to decrease growth rate.

Such a response can be ameliorated by providing the chicks with a replacement diet formulated to ensure that the nutrients are still consumed at their optimal rates, or by providing an opportunity for dietary self-selection. The latter may not always be successful (Blake *et al.*, 1984). Furthermore, it seems that supplementing diets with amino acids becomes increasingly (Waldroup, 1982).

Thyroid activity is reduced at high temperature (Clark and Das, 1974; Cogburn and Harrison, 1980; Williamson *et al.*, 1985), increased that low temperature (Kuhn and Nouwen, 1978), but again nutrient intake influences the concentrations of triiodothyronine and thryoxine in the blood (Klandorf *et al.*, 1981).

The effect of temperature on adrenal activity is complex. The concentrations of adrenaline and nor adrenaline increase in response to temperature extremes (El-Halawani *et al.*, 1973). The liver tends to hypotrophy in chronic heat (Clark and Das, 1974) with an increase in hepatic ATP citrate lyase activity but a decrease in that of hepatic phosphosfructokinase (Moss and Balvane, 1978). A low temperature results in a marked increase in cytochrome P450 content of the liver (Manning and Wyatt, 1984).

Immediate effects of high temperature on other metabolites include decreases in concentrations of circulating amino acids (Ostrowski-Meissner, 1981) and in free fatty acids (only in newly hatched chicks) whilst there is an increase in plasma glucose (Freeman, 1988) and an increase in glucose turnover (Riesenfels *et al.*, 1980). The ability to survive heat stress is influenced by the composition of the diet (McCormick *et al.*, 1979).

Conclusions

Sulphur amino acid requirement for maximum growth of broiler chicks in Indonesia was higher than sub tropical countries. Requirement of amino acid for the age period 1 to 21 d based on exponential response curve $Y = 282 + 68\ (1 - EXP^{-6.86(X - 0.27)})$ was estimated 0.87 %. Requirement of sulphur amino acid for the age period 21 to 42 d based on exponential response curve $Y = 900 + 80\ (1 - EXP^{-3.74(X - 0.29)})$ was estimated 0.72 %.

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