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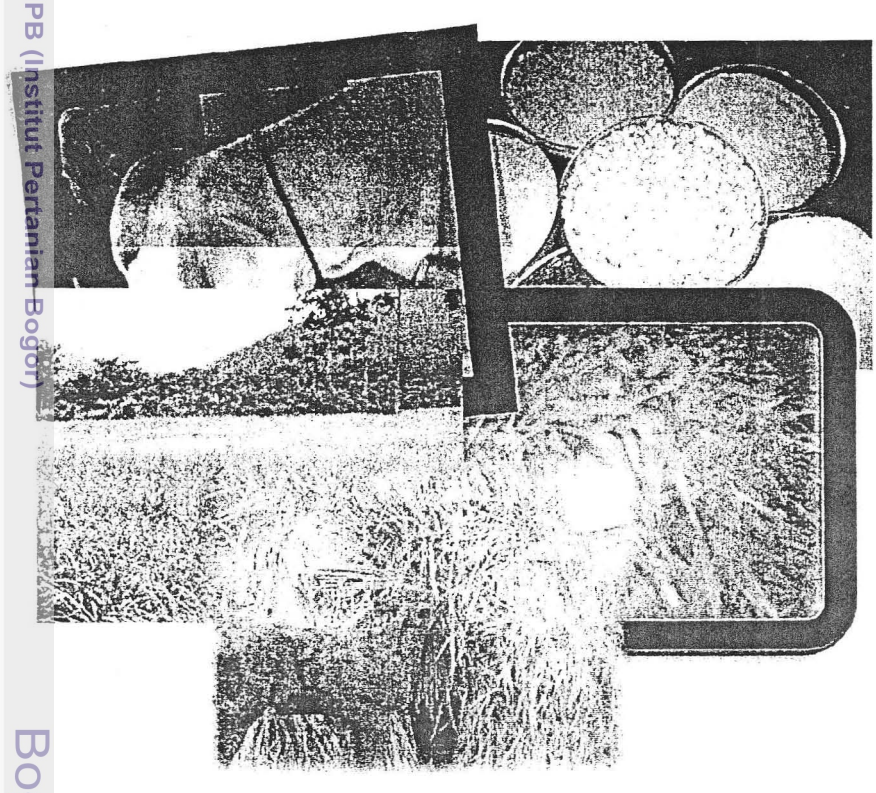
PROCEEDINGS
INTERNATIONAL SEMINAR

The 1st International Seminar and the 7th Biennial Meeting
of Indonesian Nutrition and Feed Science Association

EMPOWERMENT OF LOCAL FEEDS TO SUPORT FEED SECURITY



Jointly organized by:

FACULTY OF ANIMAL SCIENCE, JENDERAL SOEDIRMAN UNIVERSITY, PURWOKERTO INDONESIA

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PREFACE

Let us thank to God the Almighty, because of His amazing grace, this proceeding was completed. This book consists of articles presented during The 1st International Seminar and the 7th Biennial Meeting of Indonesian Nutrition and Feed Science Association on the Empowerment of Local Feeds to Support Feed Security are held by the Indonesian Nutrition and Feed Science Association in collaboration with Faculty of Animal Science, UNSOED. The objectives of this event were, among others, to provide a forum for sharing and exchanging new information and technology, discussing the way how to attain a sustainable agriculture in supporting animal feed security and also establishing a new contact, renewing friendship and network among participants.

During the two-day meeting, reviewed papers from invited speakers as well scientific papers from the participants were discussed and presented in the sessions of supporting paper and poster presentations. Selected papers were published in the Journal of the Indonesian Nutrition and Feed Science Association (AINI). The meeting was attended by around 250 participants coming from the UK, Malaysia, and Indonesia. They are 96 % from universities, 4 % from research institutes, and the rest from government representatives and private companies. On behalf of the organizing committee, we would like to extend our great appreciation to all parties (sponsor, companies, and institution) for invaluable assistances and supports to the success of this seminar.

Purwokerto, July 2010

Chair of the Organizing Committee
Dr. Sri Suhermiyati

REMARKS OF THE CHAIRMAN OF AINI

Assalamu'alaikum Wr. Wb.,

AINI that was firstly established in 1996 with the objective to gather all of the animal nutrition and feed scientists in Indonesia permitting the exchange of knowledge and experiences under spirit of brotherhood, to stimulate the advancement of science and technology in nutrition and feed science, thus benefiting to the competitiveness of animal agribusiness. At the beginning, AINI scientific meeting was held, every year (1996, 1997) but due to the economic crisis in 1998, the meeting was held biannually. The first three scientific meetings were held in IPB Bogor (2001), while the next was conducted respectively in UNDIP Semarang (2003), UNIBRAW Malang (2005), and UGM Yogyakarta (2007).

The 2009 meeting is the 7th meeting, organized by AINI members from Purwokerto especially from the Faculty of Animal Science UNSOED with the theme "Empowerment of local feeds to suport feed security" The actual meeting is declared as "The 1st International Seminar and 7th biennial meeting of AINI" This International seminar was firstly inspired by the fact that AINI has great potential to do so and it is now to show AINI member's scientific activities then ever to the stakeholders. Secondly, there is a political will of the government by offering the competitive grant for every profesional association to conduct the international symposium, and recently we have the good news that AINI is announced to get this competitive grant from Directorate General of Higher Education.

I would like also to take this opportunity to share the idea with all you, that AINI as the organization of scientist, to have a international scientific journal is a must. The journal deals with all aspects of nutrition and feed issues in tropical conditions. The Management board of AINI has taken the decision for revitalizing the AINI Journal to become the Journal of Nutrition and Feed Science, internationally recognized, by involving the International committee of lecture as the reviewers. To this end, we need fully your support and encourage the scientists especially the young scientists to publish their work in English. The accomplishment of this task will bring the association more respected in national and international level.

My sincere thanks to the Dean of the Faculty of Animal Science UNSOED, the organizing committee, sponsors, and any parties that can not be listed since we are deeply indebt to all of your effort and sacrifice to the success of this seminar. Our sincere thanks must go to the Directorate General for Higher Education Department of National Education for the grant awarded. For our invited speakers, Prof. Orskov from MLURI UK, Prof. AR Alimon from UPM Malaysia, Prof. Marsetyo, Dr. Didiek J. Rachbani, and Dr. Desianto from Indonesia, we are indebt to your effort and participation. Your views will enlighten and inspire how to empower our local feed resources in sustaining the feed security for the future.

Wassalamu'alaikum Wr. Wb.

Purwokerto, July 2010
Dr. Ali Agus

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PERFORMANCES OF BROILERS FED CORN-SOYA-PALM KERNEL MEAL DIETS SUPPLEMENTED WITH DL-METHIONINE

by

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ABSTRACT

Palm kernel meal, a by-product of the Indonesian palm oil industry, is a potential alternative of feed ingredient for poultry. The present experiment was designed to evaluate the efficacy of Sumitomo's DL-methionine supplementation in diet containing palm kernel meal based diets in broiler chicks in Indonesia. One thousand and two hundred day old chicks were allocated into 30 groups and five experimental diets. The experimental diets were as follows: a deficient in methionine diet (basal diet); deficient in methionine diets supplemented with three different levels of methionine; and a corn-soy diet as control positive diet. Metabolizable energy and nitrogen retention were determined in thirty healthy broilers of 35 day old. The chicks were assigned to one of five dietary treatments. Palm kernel meal was possible to be included in the ration of broiler chicks. Supplementation of DL-methionine increased feed intake and tended to increase body weight gain and final live weight. The supplementation of DL-methionine increased nutrient absorption and fat deposition. However high level supplementation up to 0.327% tended to stimulate over growth of intestinal villi.

Key words : palm kernel meal, DL-methionine, fat deposition, broiler

INTRODUCTION

Palm kernel meal, a by-product of the Indonesian palm oil industry, is a potential alternative of feed ingredient for poultry. Palm kernel meal (PKM) is the by-products obtained after extraction of oil from the kernel of palm fruits. Since it is produced in large amounts, the PKM become a potentially inexpensive feed ingredient for Indonesian poultry. However, the PKM is deficient in methionine.

DL-methionine produced by different private enterprises is available commercially in the form of liquid and solid product. The efficacy of the product is especially in improving feed conversion ratio in poultry. Supplementation of DL-methionine synthetic produced by Sumitomo Chemical Co, Ltd in the corn-soy based diets improved broiler performances (Jachja *et al.*, 2007). Regarding to the usage of palm kernel meal in poultry diets recently, it is essential for Sumitomo Chemical Co, Ltd Japan to evaluate the efficacy of its DL-methionine in poultry fed corn-soy-palm kernel meal based diets in Indonesia. **Objectives : 1.** To evaluate the chemical composition including the methionine content of palm kernel meal produced in Indonesia. 2. To investigate the efficacy of supplementation of Sumitomos DL-methionine in improving performances of broilers fed corn-soy-palm kernel meal based diet in Indonesia. 3. To evaluate metabolizable energy value and protein utilization including methionine of corn-soy-palm kernel meal based diets supplemented with DL-methionine. **Output : 1** Methionine status of palm kernel meal in Indonesia; 2.Establishment of the optimum level of Sumitomo DL-methionine supplemented in the broiler's corn-soy-palm kernel meal based diet; 3.Establishment of the optimum level of palm kernel meal to substitute corn as energy source in the broiler's diets

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MATERIALS AND METHOD

Location :

The feeding and metabolism trials were conducted in the Faculty of Animal Science, Bogor Agricultural University, Bogor – Indonesia.

Materials :

Two thousand of one day old chicks (DOC) of ROSS strain were purchased from Cibadak Farm, Co. Ltd. Indonesia. The diets were obtained and mixed in a small feed Mill. The chicks were kept in colony cages for feeding trial and in metabolic cages for metabolism trial. Each cage was facilitated with feeders and drinkers.

Evaluation of Feedstuffs Chemical Composition

Samples of PKM produced obtained from palm oil industry were analyzed for their chemical composition including their amino acids content. Data obtained along with the data of other feedstuffs were used in ration formulation and considering the supplementation level of DL- methionine in the diets.

Diets Preparation :

The treatment diets used for feeding and metabolism trials were formulated according to the nutrient requirement of poultry (NRC, 1994) based on corn-soy-palm kernel meal. The treatment diets consisted of 10 diets, i.e.:

1. Broiler starter diets: (S0) a deficient in methionine diet; (S1, S2, S3) deficient in methionine diets supplemented with three different levels of methionine (0.147, 0.237 and 0.327 %); and (S4) based on corn-soya diet as control positive diet
2. Broiler finisher diets: (F0) a deficient in methionine diet; (F1, F2, F3) deficient in methionine diets supplemented with three different levels of methionine; and (F4) based on corn-soy diet as control positive diet.

The diets were fed to the chickens as soon as after pabrication

Feeding Trials :

One thousand and two hundred of DOC were divided into 30 groups. The experimental ration was formulated to have deficient in methionine. The chicks were assigned randomly to one of five dietary treatments i.e. (S0) a deficient methionine diet as the basal diet; (S1) basal diet + 0.147 % DL-methionine; (S2) basal diet + 0.237 % DL-methionine; (S3) basal diet + 0.327 % DL-methionine; (S4) corn-soy based diet added 0.148% of DL-methionine as a positive control diet. At 22 days of age, the chicks were fed the finisher diets, and the treatment diets were: (F0) a deficient methionine diet as the basal diet; (F1) basal diet + 0.058 % DL-methionine; (F2) basal diet + 0.118 % DL-methionine; (F3) basal diet + 0.178 % DL-methionine; (F4) corn-soy based diet supplemented with 0.06% of DL-methionine as positive control. Diets and water were offered *ad libitum*. Once a week, the chicks were individually weighted. Feed intake and feed conversion were calculated weekly. At the end of the experimental period, two broilers from each groups, were slaughtered to evaluate the weight percentage of abdominal fat, viscera, and carcass, and the histology of intestine.

Metabolism Trial :

Thirty healthy broilers of 35 days of age were used and assigned to one of five dietary treatments i.e. (F0) a deficient methionine diet as basl diet; (F1) basal diet + 0.058 % DL-methionine; (F2) basal diet + 0.118 % DL-methionine; (F3) basal diet + 0.178 % DL-methionine; (f4) corn-soy based diet supplemented with 0.06% of DL-methionine as positive control. The animals were kept individually in metabolic cages. Metabolizable energy and nitrogen retention including methionine utilization were determined according to the modified Farrell method (1978).

Statistical Analysis :

Data from completely randomized design of feeding and metabolism trials were analyzed statistically using analysis of variance (ANOVA) according to the procedure of SAS.

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RESULTS AND DISCUSSION

1. Chemical Composition of Palm Kernel Meal

The experimental diets were composed of six main ingredients. Crude protein and amino acids content of the main ingredients of the experimental diets is presented in Table 1. Protein and amino acid content of ice bran, MBM, CGM, corn and soybean meal were in the normal range. Palm kernel meal had higher protein and amino acids content than both rice bran and corn, but it had lower protein and amino acids content than MBM, CGM and soybean meal.

2. Efficacy of Sumitomos DL-methionine Supplementation in Corn-soy-palm Kernel Meal Based Diets in Improving the Performances of Broilers Chicks.

Mean of body weight gain, final body weight, feed conversion ratio and feed intake of starter (1-21 days) and finisher (22-42 days) broilers fed diets supplemented with different level of DL-methionine are presented in Table 2.

Supplementation of 0.327% DL-methionine to the deficient methionine diet containing palm kernel meal improved ($P<0.01$) feed intake during starter and finisher period of broilers. However the response of feed intake on the DL-methionine supplementation at level 0.147% and feeding corn-soy based diet was inconsistence. Broiler chicks offered corn-soy based diet indicated lower feed intake compared to the diet containing palm kernel meal diet supplemented with 0.327% DL-methionine. Supplementation of DL-methionine to the basal diet did not affect feed conversion ratio (FCR) during the starter period. However, during finisher period, supplementation of Dl-methionine had a tendency in improvement ($P<0.3$) of feed conversion as 1.40; 6.90 and 10.92% for F1, F2 and F4, respectively compared to FCR of the chickens fed F0 diet. Café and Waldroup (2006) reported that the methionine level had no significant effect on feed conversion at 16 days of age of the chickens, however at 35, 42 and 49 days of age, supplementation of methionine in the basal diet improved feed conversion.

Table 1. Chemical composition of palm kernel meal and other ingredients composing diets supplemented methionine and offered to broiler chicks.

Amino Acids	Ingredients					
	Rice bran	MBM	CGM	Yellow corn	Soybean meal	Palm kernel meal
Crude Protein (%)	**10.68**	**43.28**	**63.52**	**7.90**	**47.78**	**16.58**
Aspartic acid (%)	0.99	4.33	4.50	0.64	6.16	1.35
Glutamic acid (%)	1.52	6.96	16.26	1.69	10.19	3.33
Serine (%)	0.48	2.03	3.74	0.43	2.65	0.67
Histidine (%)	0.26	1.00	1.37	0.24	1.34	0.26
Glysine (%)	0.54	6.26	2.11	0.35	2.15	0.78
Threonine (%)	0.40	1.99	2.34	0.30	1.95	0.47
Arginine (%)	0.79	3.75	2.30	0.44	3.93	1.74
Alanine (%)	0.62	3.80	6.00	0.61	2.10	0.67
Tyrosine (%)	0.36	1.28	3.86	0.37	1.94	0.36
Methionine (%)	**0.10**	**0.47**	**1.61**	**0.12**	**0.62**	**0.29**
Valine (%)	0.53	2.23	3.12	0.41	2.30	0.82
Phenilalanine (%)	0.45	1.93	4.50	0.44	2.65	0.68
Isoleusine (%)	0.35	1.60	2.79	0.31	2.28	0.60
Leusine (%)	0.68	3.37	10.92	0.98	3.81	1.05
Lysine (%)	0.49	3.14	1.13	0.25	3.24	0.44

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Table 2. Mean of feed intake, body weight gain, final body weight and feed conversion ratio of starter and finisher broilers fed different level of methionine

Treatment diets	Feed intake (g/bird)	Body weight gain (g/bird)	Final body weight (g/bird)	Feed conversion ratio
Starter period (0-21 days)				
S0	$1013.96^{B} \pm 15.79$	594.22 ± 65.32	634.55 ± 65.20	1.67 ± 0.09
S1	$1022.76^{B} \pm 22.13$	566.42 ± 20.91	607.20 ± 21.45	1.74 ± 0.03
S2	998.12^{B} ± 18.91	551.65 ± 20.68	592.25 ± 21.38	1.72 ± 0.04
S3	$1069.82^{A} \pm 26.21$	599.01 ± 21.00	639.59 ± 21.34	1.69 ± 0.05
S4	$1077.92^{A} \pm 20.38$	589.52 ± 37.33	629.79 ± 37.46	1.74 ± 0.11
Finisher period (22-42 days)				
F0	$2481.06^{B} \pm 106.61$	825.06 ± 49.75	1459.61±88.94	3.15± 0.29
F1	$2533.54^{A} \pm 65.91$	864.15 ± 103.92	1471.35±94.16	3.11 ± 0.49
F2	$2458.69^{BC} \pm 130.08$	874.09 ± 111.94	1466.33±97.94	2.93 ± 0.19
F3	$2652.93^{A} \pm 143.67$	931.14 ± 250.01	1570.73± 261.86	3.23 ± 0.57
F4	$2464.56^{BC} \pm 113.84$	895.93 ± 30.57	1525.72±49.17	2.81 ± 0.09

Note: Means with different superscript differ ($P<0.01$); S0= a deficient methionine or basal diet offered during starter period; S1= basal diet + 0.147 % DL-methionine; S2= basal diet + 0.237 % DL-methionine; S3= basal diet + 0.327 % DL-methionine; S4= corn-soy based diet supplemented with 0.148% of DL-methionine as positive control; F0= a deficient methionine diet as the basal diet offered during finisher period; F1= basal diet + 0.058% DL-methionine; F2= basal diet + 0.118 % DL-methionine; F3= basal diet + 0.178 % DL-methionine; F4= corn-soy based diet + 0.06% of DL-methionine as positive control diet.

The feed intake of broiler chicks in the present study was in the normal range compared to standard feed intake of the commercial Ross 308 (998.12-1077.92 g/bird versus 1069 g/bird). Supplementation of DL-methionine at level of 0.327 %(S3), and 0.178% (F3) in broiler diets containing palm kernel meal was appropriate to maintain the normal feed intake. The low feed intake of basal diet might be due to amino acids deficiency, esp. methionine. Pesti *et al.* (2005) reported that when an amino acid deficient, the birds are likely to decrease their consumption if the deficiency was severe. Feed consumption of laying hens and broilers increased due to DL-Methionine supplementation (Bunchasak and Silapasorn, 2005; Bunchasak and Keawarun, 2006).

Supplementation of DL-methionine was likely improved the nutrient untilization of palm kernel meal. Chicks fed diets supplemented with DL-methionine in the finisher period tended more efficient in utilizing the diet based on corn-soy-palm kernel meal. Pesti *et al.* (1999) reported that there was improvement in feed conversion ratio when DL-Methionine was added to the basal diet. However, there was no different in body weight, final body weight and feed conversion ratio among the treatments during starter and finisher period. The chicks offered basal diet containing palm kernel meal supplemented with DL-methionine at level of 0.327% tended to have higher body weight gain and final body weight. Final body weigh of the chickens fed S3, F1, F2, and F3 diets were 0.8, 0.8,0.5, and 7.6% higher than that fed S0 diet, respectively. Palm kernel meal indicated good nutritive value when it is included in the diet of broiler chicks.

Supplementation of DL-methionine to the corn-soy-palm kernel based diet did not improve final body weight of chicks during starter as well as finisher period. However, there was a tendency in improvement of final body weight of chicks fed corn-soy-palm kernel diets supplemented with DL-methionine except for the chickens fed S1 and S2 diets.

3. Viscera Weight and Histological Appearance of intestine

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Viscera weight of the broiler chicks fed diets supplemented witrh DL-methionine are indicated in Table 3. Supplementation of DL-methionine tended to increase liver weight, abdominal fat, reduced limp and jejunum size of broiler chicks fed diets supplemented with DL-methionine. The results indicated that DL-methionen improved the nutrient absorption and stimulate nutrient metabolism and deposition.

Histopathological appearance of intestine in broilers chicks fed different level of DL-methionine was indicated in Table 4. Deficient methionine diet reduced size of villi. Supplementation of DL-methionin stimulated the growth of villi. Supplementation of DL-methionine stimulated the growth of villi. The over growth of villi was observed in broiler chicks fed diet supplemented with 0.327% DL-methionine. The supplementation of DL-methionine at high level also stimulated the growth of coccidian.

1. Energy and Protein Utilization of Corn-soy-palm Kernel Meal Based Diet

Metabolizable energy and protein utilization of experimental diet offered to the broiler chicks during finisher period was indicated in Tabel 3. Basal diet supplemented with DL-methionine at level of 0.327% indicated the lowest Metabolizable Energi (ME) value and nitrogen retention value. Apparent metabolizable energy (AME), true metabolizable energy (TME), nitrogen corrected apparent (NCAME) and true (NCTME) metabolizable energy of the others treatment were similar. The result indicated that high level of DL-methionine supplementation in palm kernel meal containing diet up to 0.327% resulted in reduction in nitrogen retention, due to imbalance dietary amino acid content. It was likely that the basal diet containing palm kernel meal had already contained balance amino acids.

Table 4. Histopathological apperance of intestine in broilers chicks fed different level of DL-methionine.

Treatment Diets	Histological Appearance of Intestine
F0	Long and slim villi, villi was reduced in size
F1	Long, slim and dense villi, cripta lieberkhun increased (Figure 1)
F2	Long villi, rupture epithel villi (deskwamasi)
F3	Large villi, lot of line, villi ephithel was pooled, coccidian was detected
F4	Slim villi

Table 3. Viscera weight of the broiler chicks fed diets with and without supplementation of DL-methionine.

(%)	Treatment Diets				
	F0	F1	F2	F3	F4
Liver	2.21±0.29	2.29±0.31	2.35±0.32	2.41±0.33	2.32±0.35
Kidney	0.44±0.11	0.33±0.11	0.40±0.12	0.43±0.14	0.41±0.07
Heart	0.42±0.05	0.44±0.06	0.47±0.07	0.47±0.05	0.49±0.08
Lymph	0.18±0.05	0.18±0.06	0.16±0.05	0.14±0.06	0.15±0.06
Bill duct	0.06±0.02	0.07±0.01	0.07±0.03	0.05±0.03	0.09±0.03
Abdominal Fat	1.33±0.20	0.95±0.67	1.45±0.64	1.91±0.27	1.37±0.30
Pancreas	0.15±0.02	0.19±0.02	0.17±0.02	0.16±0.06	0.16±0.06
Duodenum	0.41±0.08	0.50±0.14	0.49±0.07	0.42±0.09	0.42±0.16
Jejenum	1.28±0.21	1.25±0.16	1.20±0.11	1.18±0.11	1.07±0.26
Ileum	1.04±0.14	0.97±0.25	1.05±0.21	0.98±0.07	1.07±0.14
Cecum	0.39±0.07	0.49±0.20	0.41±0.09	0.33±0.04	0.42±0.27
Colon	0.14±0.04	0.15±0.03	0.14±0.04	0.13±0.03	0.17±0.09
Total Intestines	12.35±2.65	11.05±4.01	10.70±2.25	10.21±2.79	10.69±1.79

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Table 5. Mean of energy and protein utilization in broilers chicks fed different level of DL-methionine

Treatment diets	A-ME (kcal/kg DM)	T-ME (kcal/kg as fed)	T-ME (kcal/kg DM))	NCA-ME. (kcal/kg DM)	NCT-ME . (kcal/kg DM)	Nitrogen Retention (g/ekor/day)
F0	4390^{B}±48	3984^{AB}±30	4528^{AB}±34	4222^{B}±27	3048±131	9.35^{B} ±2.38
F1	4396^{B}±61	4010^{AB}±56	4558^{AB}±64	4216^{B}±33	2944±156	8.51^{AB}±1.36
F2	4394^{B}±40	4054^{B} ±86	4608^{B}±99	4201^{B}±23	2818±174	7.93^{AB}±3.89
F3	4205^{A}±207	3942^{A}±32	4481^{A}±35	4078^{A}±135	3095±260	5.02^{A} ±3.36
F4	4430^{B}±19	4007^{AB}±15	4555^{AB}±17	4246^{B}±15	2975±64	11.23^{B}±0.70

Note: Apparent metabolizable energy (AME), true metabolizable energy (TME), nitrogen corrected apparent (NCAME) and true (NCTME).

CONCLUSION

Palm kernel meal was possible to be included in the ration of broiler chicks. Supplementation of DL-methionine increased feed intake and tended to increased body weight gain and final live weight. The supplementation of DL-methionine increased nutrient absorption and fat deposition. However, high level DL-methionine supplementation up to 0.327% tended to stimulate over growth of interstinal villi.

REFEERENCES

Café, M. B. and P. W. Waldroup. 2006. Interaction between levels of methionine and lysine in broiler diets changed a typical industry intervals. Int. J. Poult. Sci., 5 (11) : 1008-1015

Huyghebaert, G. 1993. Comparison of DL-methionine and methionine hydroxy analogue- free acid in broilers by using multi-exponential regresion model. Bri. Poult. Sci., 34 : 351-359.

Jachja, J., N. Ramli, M. Ridla, Sumiati and T. Toharmat. 2007. The effectiveness of DL-Methionine suplementation in diet on performance of starter and finisher broilers. Proceeding of Association of Nutrition and Feed Scientiest Seminar Gadjah Mada University, July 26-27th 2007.

Lesson, S., J. D. Summers dan L.J. Caston. 1992. Responses of broilers to feed restriction or diet dilution in the finisher period. Poult. Sci., 71 : 2056-2064.

Pesti, G.M., R.I. Bakalli, J.P. Driver, A.Atencio, and E.H. Foster. 2005. Poultry Nutrition and Feeding. Trafford Publh. Canada.

Pesti, G. M., R. I. Bakalli, H. M. Cervantes and K. W. Bafundo. 1999. Studies of semduramicin and nutritional responses : Methionine levels. Poult. Sci 78 :1170-1176.