UNIVERSITI PUTRA MALAYSIA

EFFECTS OF L-LEUCINE SUPPLEMENT ON THE GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF GROWER- FINISHER BROILERS FED WITH VARYING LEVELS OF PROTEIN AND ENERGY

EDI ERWAN
ITA 2009 1

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By

EDI ERWAN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia in Fulfilment of the Requirements for the Degree of Master of Science

October 2009

DEDICATION

I wish to dedicate this thesis to my beloved family, my wife Susi Fitria, who always understand and give me loving support. My sons Muhammad Jilan Naufal, Muhammad Dzaki Manaf dan Muhammad Faiz Ramadhan

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman : Professor Abdul Razak Alimon, PhD

Faculty/Institute : Institute of Tropical Agriculture

Four studies were conducted to determine the effects L-leucine supplementation on the growth performance and carcass characteristics of grower-finisher chickens fed diets containing different levels of crude protein (CP) and metabolizable energy (ME). Experiment 1 utilized a series of 4 diets that were formulated to contain ME levels (3200 Kcal/kg or 3000 Kcal/kg) and supplemented with two levels of L-leucine either 0 or 0.5%. In Exp. 1, 80 Cobb broilers were used to examine the effect of L-leucine supplementation on growth performance and carcass characteristics fed different levels of energy. There was no interaction between the dietary levels of L-leucine and ME. The supplementation 0.5% of L-leucine had no significant effect on FI, WG and FCR but significant increased in carcass weight up to 9% was observed. The decrease in ME from 3200 to 3000 kcal/kg also did not

affect FI and FCR, but WG decreased up to 7.4%. Similarly, reducing ME had no significant effect on carcass composition and sensory characteristics.

Exp. 2, The effect of the growth performance and sensory characteristics in reducing CP supplemented by L-leucine. A series of 6 diets that were formulated to contain CP levels of 20 and 18% at each of three levels of L-leucine supplementation (0, 0.5 and 0.67%). Treatments were applied to Cobb 180 broilers distributed across 36 floor pens with 5 chicks per pen while the parameters measured and procedures were similar to experiment 1. There was no interaction between the level of L-leucine supplementation and CP levels. FI, WG and FCR were not affected with increasing levels of L-leucine supplementation. Breast meat yield in numerically increased when added by L-leucine to a level of 0.5%. However a significant decrease of breast meat obtained when added with L-leucine to a level reached 0.67%. Similarly, the sensory analysis indicated no significant differences in tenderness, juiciness, flavor, aroma, and overall acceptability. Bone and lean were not affected with increasing levels of L-leucine supplementation. Fat was decreased ($P<0.05$), when leucine was added at 0.5%.

In experiment 3, four experimental diets were formulated with added L-leucine with dietary levels as follow: D1 (control, ME 3200 kcal/kg; 20% CP without additional of L-leucine), D2 (ME 3000 kcal/kg; 18% CP added by 0.5% L-leucine), D3 (ME 3000 kcal/kg; 18% CP added by 0.67% L-leucine) and D4 (ME 3000 kcal/kg; 20% CP added by 0.75% L-leucine). Chickens fed excessive levels of leucine grown at a significantly slower rate than the control, whereas addition of 0.5% L-leucine caused the greatest depression. Similarly, the growth depression accompanied by significant worsened of FCR. In contrast, breast meat increased ($P<0.01$) as supplementation of

low CP and ME with L-leucine, whereas level of 0.67% was the maximum weight. Furthermore, heart was not affected ($P>0.05$). Supplementation of L-leucine significantly ($P<0.01$) decreased lean, bone and fat compared to control.

In Exp. 4, four experimental diets were formulated with added L-leucine with constant level as follows: D1 (control, ME 3200 kcal/kg; 20% CP without additional of L-leucine), D2 (ME 3000 kcal/kg; 16% CP added by 0.5% L-leucine), D3 (ME 3000 kcal/kg; 18% CP added by 0.5% L-leucine) and D4 (ME 3000 kcal/kg; 20% CP added by 0.5% L-leucine). FI was not significantly affected by the treatments but BWG decreased as CP decreased and supplementations with L-leucine did not ameliorate this effect. Similarly, supplementation of L-leucine in low CP worsened FCR. Live weight, carcass, abdominal fat, gizzard and liver decreased ($P<0.05$) as supplementation in low CP with L-leucine compared to control diet. In contrast, breast meat increased ($P<0.01$) as supplementation of low CP with L-leucine. In conclusion, L-leucine supplementation up to 0.67% either in 2% decrease of CP or 3000 Kcal/kg ME did not affect the growth performance and sensory characteristic. Supplementation of L-leucine up to 0.5% in diets tend to increase carcass weight and breast meat. Lowering CP level than 2% seems worthwhile for slow growing broiler in grower-finisher period and induced fat deposition.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master of Science

EFFECTS OF L-LEUCINE SUPPLEMENT ON THE GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF GROWER- FINISHER BROILERS FED WITH VARYING LEVELS OF PROTEIN AND ENERGY

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Empat eksperimen telah dijalankan bagi menentukan kesan L-leucine sebagai makanan tambahan atas prestasi pertumbuhan dan ciri-ciri karkas yang meliputi komposisi badan, ciri-ciri sensori ayam pembesaran-penamat (grower-finisher). Ternakan ini diberi diberikan makanan yang mempunyai aras protein kasar dan tenaga metabolise (ME) yang berbeza. Dalam eksperimen 1 menggunakan 4 kombinasi makanan yang mengandung aras ME 3,200 dan 3,000 Kcal/kg, masing-masing diberikan 0 atau 0.5% L-leucine telah dikaji. Eksperimen ini menggunakan 80 ekor baka Strain Cobb yang dipelihara dalam 16 reban dengan 5 ekor setiap reban. Penambahan L-leucine hingga 0.5% tiada mempengaruhi prestasi pertumbuhan namun secara signifikan meningkatkan karkas sehingga 9%. Pengurangan ME daripada 3,200 kepada 3,000 kcal/kg juga tidak memberi kesan terhadap pengambilan makanan dan kecukupan makanan, namun berat badan

menurun hingga 7.4%. Pengurangan ME tidak memberi kesan terhadap komposisi karkas dan ciri-ciri sensori.

Eksperimen 2 bertujuan untuk menilai kesan pengurangan protein yang ditambahkan L-leucine terhadap prestasi dan sifat-sifat karkas. 6 jenis diet yang mengandung 2 aras protein kasar (20 dan 18%) dan 3 aras penambahan L-leucine (0, 0.5 and 0.67%). Eksperimen ini menggunakan 180 ekor ayam pedaging baka Cobb yang ditempatkan pada 36 buah reban dengan 5 ekor setiap reban. Parameter dan kaidah pengukurannya adalah sama dengan eksperimen 1. Pengambilan makanan, pertambahan berat badan dan FCR tidak dipengaruhi dengan peningkatan aras pemberian L-leucine. Hasil daging dada didapati meningkat dengan penambahan leucine pada aras 0.5% didalam diet. Namun begitu penurunan yang signifikan telah dilihat apabila penambahan arasnya ditingkatkan kepada 0.67% dalam makanan. Penambahan L-leucine tidak memberi kesan terhadap ciri-ciri sensori, begitu juga dengan berat tulang dan daging. Kandungan lemak berkurang apabila leucine ditambah pada aras 0.5%.

Dalam eksperimen 3, empat makanan ternak diformulasikan dengan diberi beberapa aras L-leucine. D1 (sebagai kawalan. mengandungi ME 3,200 kcal/kg, 20% CP tanpa penambahan L-leucine), D2 (3000 kcal/kg; 18% CP dengan penambahan 0.5% L-leucine), D3 (ME 3000 kcal/kg; 18% CP dengan penambahan 0.67% L-leucine) dan D4 (ME 3000 kcal/kg; 20% CP dengan penambahan 0.75% L-leucine). Eksperimen ini menggunakan 100 ekor ayam. Ayam yang di beri lebih banyak L-leucine ternyata lebih lambat membesar dibandingkan dengan kumpulan kawalan, Manakala penambahan L-leucine pada aras 0.5% menyebabkan penurunan lemak

tertinggi. Walau bagaimanapun, hasil daging dada meningkat dengan penambahan L-leucine apabila pemberian L-leucine pada aras 0.67% memberi hasil tertinggi dibandingkan dengan aras-aras yang lain. Selanjutnya, berat jantung tidak dipengaruhi oleh penambahan L-leucine.

Dalam eksperimen ke 4, empat makanan diformulasikan dengan penambahan L-leucine pada aras yang tetap (0.5%). Susunan makanan adalah seperti berikut: D1 (sebagai kawalan mengandungi ME 3,200 kcal/kg, 20% CP tanpa penambahan L-leucine), D2 (3000 kcal/kg; 18% CP dengan penambahan 0.5% L-leucine), D3 (ME 3000 kcal/kg; 16% CP dengan penambahan 0.5% L-leucine) dan D4 (ME 3000 kcal/kg; 20% CP dengan penambahan 0.5% L-leucine). Eksprimen ini menggunakan 60 ekor ayam. Tidak ada kesan perlakuan terhadap pengambilan makanan. Walau bagaimanapun berat badan didapati menurun dengan berkurangnya aras protein. Penambahan L-leucine saja tidak meningkatkan prestasi pertumbuhan ayam dibandingkan dengan kumpulan kawalan. Berat hidup, karkas, lemak abdomen, empedal dan hati menurun sejalan dengan penambahan L-leucine pada makanan berprotein rendah jika dibandingkan dengan kumpulan kawalan.

Sebagai kesimpulan, bahwa penambahan L-leucine sehingga ke aras 0.67% tidak memberi kesan terhadap prestasi dan ciri-ciri sensori sama ada di dalam makanan yang dikurangkan 2% aras proteinnya, ataupun pengurangan tenaga metabolismenya menjadi 3000 kcal/kg.

Penambahan L-leucine pada aras 0.5% di dalam makanan memberi kecenderungan ke arah peningkatan berat karkas and daging dada. Pengurangan protein melebihi

2% akan mengakibatkan penurunan kadar pertumbuhan ayam pedaging disamping menggalakkan penimbunan lemak yang lebih banyak.

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I certify that an Examination Committee met on June 2008 to conduct the final examination of Edi Erwan on his Master thesis entitled" Effects of L-Leucine Supplement on The Growth Performance and Carcass Characteristics of Broilers Chicken Fed with Varying Protein and Energy Levels' in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia(Higher Degree) Regulation 1981. The Committee recommends that the candidate be awarded the relevant degree.

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This thesis is submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Science. The members of the supervisory Committee as follows:

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Date: 14/1/2010

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at University Putra Malaysia or at any other Institution.

E D I E R W A N

Date: 4/9/2009

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LIST OF ABBREVIATIONS

wk	Week
d	Day
BCAAs	Branched Chain Amino Acids
hr	Hour
cal	Calorie
kcal	Kilo Calorie
g	Gram
kg	Kilogram
BWG	Body Weight Gain
CP	Crude Protein
FI	Feed intake
FCR	Feed Conversion Ratio
ME	Metabolizable Energy
FCR	Feed Conversion Ratio
EAA	Essential Amino Acids
NRC	National Research Center
Glu	Glumatic Acid
E:P	Energy: Protein
WHC	Water Holding Capacity
AOAC	Association of Official Analytic Chemist
WG	Weigh Gain

CHAPTER 1

INTRODUCTION

Proteins are organic compounds made up of 22 different amino acids (AA) or derivates arranged in a linear chain and linked together by peptide bonds between the carboxyl and amino groups of adjacent AA residues. These nutrients also work together to achieve a particular function, and they are often associated to form stable complexes (Maton *et al*., 1993). Crude protein (CP) is the most crucial nutrient in determining feed cost in the poultry production (Witjetten *et al*., 2004a). Excessive CP in the diet will affect a large portion of diet cost, and may negate economic returns due to suboptimal growth and meat yields (Kidd *et al*., 2005). In addition, as there may be a rule to reduce nitrogen excretion in future, reduction of nitrogen and phosphorus in animal wastes will be one of the primary choice in the diet formulation. (Si *et al*., 2004). Therefore, there is a revenue in broiler production enterprise that can be managed by changing dietary CP (Eits *et al*., 2005). The branched-chain amino acids (BCAAs)-leucine, isoleucine, and valine are essential nutrients that must be obtained from food (Harper, 1984). These AA play important roles in protein synthesis and energy production. BCAAs make up 35-40% of the essential amino acids in body protein and 14% of the total amino acids in skeletal muscle.

Although many research have been documented which examined the effects of low CP diets on performance and carcass characteristics, but only a few have described the effects of supplementing BCAAs, in particular leucine on performance and

carcass characteristics of grower-finisher broiler.

Together with amino acids, the metabolizable energy (ME) level in broiler diets play an important role in determining the growth performance and carcass characteristics of the birds. When fed *ad libitum*, broiler chickens will consume sufficient feed to satisfy their energy requirements and hence, energy level is crucial in determining dry matter intake. If the energy intake of the broiler changes, so does the intake of protein. The energy requirement of broiler decreases as the ambient temperature increase above 21^{o}C. Reduction in energy requirement in chickens is mainly due to the reduction in requirement for maintenance whereas the energy requirement for production is not influenced by environmental temperature (Hurwitz et al., 1980). High energy broiler starter diets result in extra deposition of fat (Holsheimer and Jensen, 1991) resulting in the wastage of dietary energy. Hence, to achieve optimal broiler performance especially in tropical environment requires a suitable combination both of ME and CP. This attempt not only to ensure optimum utilization of each and every nutrient in the diets and help to reduce the cost of production and environmental pollution associated with the loss of nitrogen in excreta. There has been no research conducted with grower-finisher broiler in low CP or ME diets that supplemented by L-leucine. The present study was therefore designed to investigate the effect of altering dietary CP and ME on the performance and carcass characteristics of broiler chickens supplemented L-leucine during grower-finisher periods.

CHAPTER 2

LITERATURE REVIEW

2.1. Protein in Broiler Ration

In general, protein are composed of carbon, hydrogen, oxygen, nitrogen and in some cases, sulfur. The percentage of nitrogen in protein is on average 16%. Voet *et al* (1999) stated that proteins play a role in all biological process because essentially all molecular transformations in body metabolism are mediated by protein catalyst, or enzymes. The type and level of dietary protein in animal ration influence the productivity of farm animals. Proteins are comp long chains of up to 22 amino acids that are linked together by peptide bonds. Dietary protein content has a great effect on the growth performance of the birds and is the most expensive nutrient in broiler diets (Drain and Waldroup, 2002). Dietary CP is used by broilers for many functions, the most important being accretion of protein as broiler meat (Aftab *et al*., 2006). Hence, the recent issues regarding the environment and the high cost of protein supplement affect nutritionist to decrease CP levels in diets while sustaining performance. Since 1950's methionine and lysine as supplements have been successfully used in poultry diets allowing for reduction in CP levels. Moreover, with the development of additional feed-grade amino acids such as threonine and tryptophan the chance exists to decrease the CP level in diets even further since it is commonly agreed that greater performance in chicks can be achieved if essential amino acids (EAA) in low CP diet equal to those needed in higher CP diets (Pinchasov, 1990).

However, the effects of replacing low CP with several amino acids in broiler diets is not always consistent (Bregendahl *et al.*, 2002; Jiang *et al.*, 2005; Si *et a.*, 2004; Farran *et al.*, 2003). The reason for the failure to achieve the performance with low protein diets fortified with amino acids are not clearly understood. BCAAs have been recognized as deleterious to many species when fed in excess (D'Mello and Lewis, 1970, Farran *et al.*, 2003). Such treatments resulted in depressed food intake and reduced growth. It was reported that dietary excess of leucine content depressed weight gain and feed intake during the starter period of broiler chickens (Edmon and Baker, 1987; Smith and Austic, 1977; Farran and Thomas, 1990; Penz *et al.*, 1984), but increased carcass weight of growing-broiler chickens (Keer and Kidd, 1999). A three-stage feeding program of protein requirement during starting, growing and finishing periods as recommended by the NRC (1994) is shown in Table 2.1.

Table 2.1. Three-stage feeding program in broilers (NRC, 1994)

	Three-stage program		
	Starter	Grower	Finisher
Age (days)	0-3	3-6	6-8
% protein	23	20	18

Increasing the dietary protein increases carcass protein and reduces carcass fat of broilers. Little or no improvement in weight is achieved when dietary protein is raised above 20% (Summers *et al.*, 1968; Brown & McCartney, 1982). Less dietary protein and more dietary energy was shown by Donaldson *et al* (1956), to be required per unit of gain, as the calorie-to protein ratio is increased.

2.2. Energy in broiler rations

Energy is one of the most important factors in broiler diets and plays an important