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METABOLIZABLE ENERGY AND CRUDE PROTEIN REQUIREMENTS IN NATIVE CHICKENS IN TROPICAL LOWLAND AREAS

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Abstract

This research investigates the metabolic energy (ME) and crude protein (CP) requirements of native chickens in tropical lowland areas, focusing on their feed intake, energy, and protein needs for optimal growth. Using a Completely Randomized Design (CRD), the study assessed four different feed treatments with varying ME and CP contents. The treatments in this study were: native chickens that received feed with a metabolizable energy (ME) content of 2700 kcal/kg and crude protein (CP) 14% (A), ME 2800 kcal/kg and CP 15% (B), ME 2900 kcal/kg CP16% (C), ME 3000 kcal/kg and CP 17% (D). Feed treatment with different metabolized energy and crude protein content did not significantly influence the variables of air temperature, relative humidity and temperature humidity index. The metabolic energy requirements for native chickens aged 0-8 weeks in tropical lowlands range from 47.76 kcal/head/day to 64.63 kcal/head/day. The crude protein requirement ranges from 2.25 g/day to 3.84 g/day. Average feed consumption per bird is 20.48 g/day. The study concludes that varying feed treatments do not impact the cage microclimate, and native chickens in the tropical lowlands require feed with metabolic energy content 2656.25 kcal/kg and 14.36% crude protein.

Key words: native chicken, cage microclimate, energy metabolism, crude protein

INTRODUCTION

Joper chickens represent a notable improvement in the genetic quality of native chickens, achieved by crossing egg-laying female chickens with male Bangkok native chickens. Advances in breeding technology have enabled more precise crossing, selection, and breeding, resulting in new local strains with enhanced characteristics. Among these superior strains, the Joper chicken stands out. This crossbreed combines the fast growth rate of commercial poultry with the rich, traditional meat flavor of native chickens, making it popular in areas where both flavor and efficient production are valued.

The high growth rate of Joper chickens requires increased energy and protein intake compared to native chickens. Research by Nuriyasa *et al*. (2014) on rabbits showed that animals raised in different microclimate conditions had varied maintenance energy and protein requirements. For instance, maintenance energy needs for rabbits in tropical climates were higher than those for rabbits in subtropical areas. These findings imply that environmental factors, particularly air temperature, humidity, and the discomfort index, can significantly influence the nutrient needs of animals, including poultry.

For Joper chickens raised in tropical lowland areas, heat stress is a critical factor affecting productivity. Nuriyasa *et al.* (2016) reported that heat stress in poultry can reduce growth efficiency, as stressed chickens use more metabolic energy for maintenance than for growth, leaving less energy available for production. This higher maintenance energy expenditure is necessary for animals in hot climates to regulate their body temperature and manage environmental stressors, but it reduces the energy left for growth and development. Given these factors, adjusting feeding strategies to meet the increased metabolizable energy (ME) and crude protein (CP) needs of Joper chickens is essential for achieving optimal growth and productivity in tropical lowland conditions.

The nutritional needs of Joper chickens vary with their growth stage and environmental conditions (Ariesta *et al*., 2015). Kaleka (2015) indicated that starter-phase Joper chickens, around eight weeks old, require 2900 kcal of metabolizable energy (ME) and 18% crude protein (CP) to support their growth. According to the Indonesian National Standard (2016), Joper chickens generally require 2900 kcal/kg of ME and 19% CP. Similarly, Setiawan (2018) found that Joper chickens aged 4 to 12 weeks benefit from 2800 kcal/kg of ME and 17.5% CP. These standards, however, are based on comfortable, controlled environmental conditions.

In tropical lowland areas, where heat stress is common, Joper chickens may have higher energy and protein requirements due to increased maintenance needs (Nuriyasa *et al*. 2014). Heat stress affects metabolic processes, often increasing the need for ME and CP for basic physiological functions rather than growth or production. This makes it essential to adjust nutrient levels in feed to support optimal productivity and allow Joper chickens to reach their genetic potential despite environmental challenges.

RESEARCH METHODS

Location and experimental cages

The research on the nutrient requirements of Joper chickens in tropical lowland areas was conducted in controlled cage systems at Dajan Peken Tabanan Village, Tabanan District, Bali Province. The experimental site is situated at an altitude of 150 meters above sea level (asl), a characteristic elevation for many tropical lowland areas. The height of the research site was measured using a YCM brand altimeter, made in Japan, ensuring accurate data for environmental conditions.

Experimental design

The experiment employed a Completely Randomized Design (CRD) with four treatments and six replications, with each experimental unit consisting of 10 Joper chickens. This design allowed for a systematic evaluation of different nutritional formulations on Joper chicken performance under tropical conditions. The treatments used in this research were: Treatment A: Joper chickens fed with a metabolizable energy (ME) content of 2700 kcal/kg and 14% crude protein (CP). Treatment B: Joper chickens fed with a ME content of 2800 kcal/kg and 15% CP. Treatment C: Joper chickens fed with a

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ME content of 2900 kcal/kg and 16% CP. Treatment D: Joper chickens fed with a ME content of 3000 kcal/kg and 17% CP. Each treatment was replicated six times to ensure the reliability of results, providing a robust analysis of how varying levels of ME and CP impact Joper chicken growth and productivity in tropical lowland conditions.

Treatment feed

The experiment utilized a variety of feed ingredients, which were combined to meet the different treatments' requirements for metabolizable energy (ME) and crude protein (CP). The feed ingredients used in the formulation were yellow corn, rice bran, fish meal, coconut oil, mixed minerals, and NaCl (sodium chloride). These ingredients were carefully selected to provide the necessary nutrients while maintaining the required energy and protein levels for each treatment. The composition of the feed ingredients and the nutrient content in the treated feeds are summarized in Table 1 and Table 2, which present the specific formulations and nutritional breakdown for each treatment group. The feed formulation aimed to meet the target levels of ME and CP for each treatment while ensuring a balanced diet for the Joper chickens

Table 1 Composition of Treatment Feed Ingredients

Feed ingredients (%)	Treatment			
	A	B	C	D
Yellow Corn	45	45.4	45	46
Rice Bran	30.6	27.9	26.8	22.1
Fish meal	11.7	14	16	18.7
Coconut oil	1	2.7	4.4	5.5
Tapioca flour	11	9.3	7.1	7
Mineral Mix	0.45	0.45	0.45	0.45
NaCl	0.25	0.25	0.25	0.25
Total	100	100	100	100

Table.2 Nutrient Content of Treatment Feed

Feed Nutrients	Treatment			
	A	B	C	D
Metabolic Energy (Kcal/kg)	2705.75	2802.47	2903.92	3003.88 [1)]
Crude Protein (%)	14.07	15.09	16.01	17.02 [1)]
Fat (%)	7.05	6.992	9.25	6.63 [2)]
Crude Fiber (%)	4.89	4.56	4.06	3.89 [1)]
Ca (%)	0.42	0.47	1.07	0.55 [2)]
P (%)	0.33	0.38	0.6	0.43 [2)]

1): Proximate analysis at the Animal Nutrition Laboratory. Faculty of Animal Husbandry. Udayana University

2): Calculations based on SNI (2016)

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Research Variables

Microclimatic variables

In addition to monitoring the Joper chickens' growth and nutritional intake, the experiment also measured key microclimate variables within the cages to assess the environmental conditions throughout the study. These variables included temperature, humidity, and the Temperature-Humidity Index (THI), which were measured at three different times during the day: 7:30 AM, 1:30 PM, and 5:30 PM. Microclimate measurements were taken at three intervals: at the start of the study, at the midpoint, and at the end of the study, with each measurement period lasting for seven days. These measurements were essential to track any fluctuations in temperature and humidity that could influence the chickens' metabolic energy needs and overall productivity in the tropical lowland environment.

Energy balance in the body of joper chickens

To assess energy retention in Joper chickens, measurements were taken at both the start of the experiment (at day-old chick stage, DOC) and the end of the study (at 8 weeks of age). Energy retention was determined by evaluating the body composition and nutrient content in the chickens from each treatment group.

Sample preparation

At both the beginning and end of the experiment, a subset of Joper chickens from each treatment was selected and slaughtered. The chicken bodies were then blanched to ensure uniformity in body composition. The fresh weight of each chicken's body was measured before proceeding with further analysis.

Analysis of energy and protein content

To determine the energy and protein content of the chicken bodies, samples were placed in an oven for drying. Following this, the dried samples were analyzed using a bomb calorimeter to measure caloric content and the Kjeldahl method to determine protein content. These measurements provided insights into the energy and protein retained in the body at both the start and end of the experiment, allowing for a comparison across different feed treatments.

Calculating energy retention

The energy retention of the chickens in each treatment was calculated based on the differences in energy content from the beginning to the end of the study. This data allowed for an assessment of how the varied dietary ME and CP levels influenced energy storage and growth in Joper chickens under tropical lowland conditions. Energy retention was obtained by slaughtering Joper chickens at the beginning of the experiment (DOC) and at the end of the study (8 weeks of age). The body of the joper chicken in each treatment was blanched until the body composition was evenly mixed and the fresh weight of the chicken's body was weighed. The chicken's body was placed in the oven and then analyzed using a bomb calorimeter and Kejelldhal which aimed to determine the energy and protein content in the body of the joper chicken at the beginning and end of the experiment.

The energy requirements and retention in Joper chickens were determined using a combination of gross energy, metabolizable energy (ME), and energy retention (RE) measurements. These measurements allowed for a detailed understanding of the chickens' energy needs under tropical lowland

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conditions.

Feed and fecal energy measurement

The gross energy content of each feed type was measured using a bomb calorimeter, while the nutrient composition was determined through proximate analysis, following the AOAC (1984) method. Fecal samples were collected and analyzed for energy content using a bomb calorimeter. Protein content in feces was determined through Kjeldahl analysis, also in accordance with AOAC (1984) guidelines.

Calculation of Metabolizable Energy (ME):

The total energy intake was determined by multiplying the gross energy content of the feed by the total amount of feed consumed. Metabolizable energy (ME) was calculated using the total collection method, where the energy excreted in feces was subtracted from the total feed energy intake. This calculation provided an accurate measure of the energy available for growth and maintenance after accounting for energy losses.

Determination of Energy Retention (RE)

Energy retention was calculated as the difference in body energy between the beginning and the end of the study. The body energy content at both points was measured using bomb calorimetry. Heat production (HP) was then estimated by subtracting ME from RE, indicating the amount of energy expended as heat rather than retained in the body.

Maintenance and Growth Energy Requirements

Maintenance energy represents the energy required for basic life functions without any growth (i.e., where energy retention RE = 0). The maintenance energy requirement was estimated by examining the relationship between ME intake and RE. If ME intake increased by ΔME, an increase in RE by ΔRE was observed. The ratio $\Delta RE/\Delta ME$, known as partial efficiency (Ef), reflects the conversion of ME to RE above basic maintenance needs. Maintenance energy (Em) was calculated using the formula: $Em = ME - RE/Ef$. The energy required for growth was determined by adjusting the RE for partial efficiency. Thus, the total energy requirement for Joper chickens is the sum of maintenance energy and growth energy, as outlined by Nuriyasa *et al.* (2014).

Protein balance in the body of joper chickens

To assess protein balance and requirements in Joper chickens, key parameters were measured, including protein consumption, protein digestion, protein retention, and protein efficiency. These measurements helped determine the chickens' total protein needs for growth and maintenance.

Protein Consumption

Protein consumption was calculated by multiplying the amount of feed consumed by the protein content of the feed. This measure provided the total protein intake for each chicken across the different treatment groups**.** Digested protein was determined by calculating the difference between protein consumption and the protein content found in feces. This value indicates the amount of protein absorbed by the chickens, adjusted for any losses during digestion**.**

Protein Retention

Protein retention reflects the amount of protein incorporated into the body over the experimental period. It was calculated by subtracting the initial protein content in the body (at the start of the study) from the final protein content (at the end of the study). This value represents the net protein retained for

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growth and maintenance.

Protein Requirements for Growth:

Protein requirements for growth were calculated from the amount of protein retained in the body, corrected for protein digestibility and the biological value of the protein. These adjustments ensure that the protein intake supports growth effectively, given the digestibility and quality of the dietary protein sources.

Maintenance Protein

Maintenance protein was calculated by subtracting the protein required for growth from the total protein consumed. This value represents the protein needed to support basic physiological functions without additional growth.

Total Protein Requirements

The total protein requirements for Joper chickens were determined by summing the protein needed for maintenance and the protein required for growth. This comprehensive measure provided insights into the optimal protein intake levels for supporting both maintenance and growth under the conditions of the experiment. This approach to calculating protein balance and requirements allowed for a detailed assessment of the protein needs of Joper chickens, considering both the quantity and quality of protein necessary to support their rapid growth and adaptation to tropical lowland conditions.

Data Analysis

The data obtained were analyzed using a general linear model (GLM) and carried out with the IBM SPSS Statistics 25 software program. The Least Significant Difference (LSD) test was used to compare mean differences.

RESULTS AND DISCUSSION

Cage Microclimate

The air temperature in the joper chicken cage that received feed treatment with a metabolizable energy of 2700 kcal/kg and 14% crude protein (A) caused a cage temperature of 27.12 ºC. while the temperature of the Joper chicken cage that was treated with feed with a metabolizable energy of 2800 kcal/kg and crude protein 15% (B). metabolized energy 2900 kcal/kg and crude protein 16% (C). metabolized energy 3000 kcal/kg and 17% crude protein (D) were respectively 0.81%. 0.18%. and 1.07% higher ($P>0.05$) compared to treatment A. Treatment A caused relative humidity in the cage 75.67%. while treatments B. C. and D each produced relative humidity of 76.02%. 75.23% and 75.44%. which were statistically not significantly different ($P>0.05$) compared to treatment A. The Temperature Humidity Index (THI) in treatment A was 26.10 while treatments B. C. and D produced a Temperature Humidity Index of 1.26%. 0.19%. and 1.03% higher ($P>0.05$) than treatment A as in (Table 3)

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Table 3. Microclimate of Joper Chicken Cages in Tropical Lowland Areas with Different Feed Treatment

Variable	Treatment				SEM
	A	B	C	D	
Temperature (°C)	27.12[a]	27.34[a]	27.17[a]	27.41[a]	0.13
Relative Humidity (%)	75.67[a]	76.02[a]	75.23[a]	75.44[a]	0.16
Temperature Humidity Index (THI)	26.10[a]	26.43[a]	26.15[a]	26.37[a]	0.11

1) A: Joper chickens that receive feed treatment with a metabolized energy content of 2700 kcal/kg and crude protein 14%. B: metabolized energy content 2800 kcal/kg and crude protein 15% C: metabolized energy content 2900 kcal/kg and crude protein 16%. D: content metabolized energy 3000 kcal/kg and crude protein 17%
2) The same superscript on the same line indicates not significantly different (P>0.05) and different superscripts on the same row indicate significant differences (P<0.05)
3) SEM : *Standard Error of The Treatment Means*

Different energy and protein content in feed does not affect cage temperature. Differences in metabolic heat caused by differences in energy and protein consumption in different feed treatments did not affect the measured temperatures. Nuriyasa *et al.* (2016) stated that higher energy and protein consumption causes the metabolic heat produced to be higher as well. Cage ventilation allows air movement so that heat differences from differences in animal metabolism do not affect the temperature measured in the cage. This opinion is supported by Nuriyasa *et al* (2017) who state that climate elements such as solar radiation. air humidity and wind speed in the cage will interact to influence the temperature measured in the cage. Table 3 shows that feed treatments with different energy and protein contents have no effect on relative humidity. This means that there is no real difference in the Temperature Humidity Index (THI) of the cage between food treatments A. B. C and D.

Energy Balance in the Body of Joper Chickens

Proximate analysis and calculations showed that the gross energy consumption of joper chickens that received feed treatment D was the highest (88.46 kcal/kg) but was not significantly different (P>0.05) from feed treatment C. Feed treatments B and A respectively 18.13% and 22.15% lower than feed treatment D (Table 4). The energy content in chicken feces treated with feed A. B. C. and D was respectively 8.31 kcal/bird/day. 10.21 kcal/bird/day. 11.20 kcal/bird/day and 12.04 kcal/bird/day. which was not statistically significantly different (P>0.05). Feed treatment D produced metabolized energy of 84.01 kcal/bird/day. feed treatment C was 9.77% lower (P>0.05). Feed treatments B and A produced metabolized energy respectively 25.96% and 27.92% lower (P<0.05) than feed treatment D.

Energy retention in Joper chickens that received feed treatment D was 58.12 kcal/bird) which was not significantly different compared to feed treatment C. Feed treatments B and A produced energy retention of 25.07% and 24.88% respectively (P< 0.05) compared to feed treatment D. Joper chickens

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receiving feed treatment D produced heat production of 25.90 kcal/bird/day. feed treatment C produced heat production of 23.45 kcal/bird/day. no difference significant (P>0.05) compared to treatment D. Feed treatments B and A produced heat production respectively 27.95% and 34.75% lower than feed treatment D. The calculation results showed that the maintenance energy of joper chickens that received the treatment D was 18.13 kcal/bird/day. not significantly different (P>0.05) from feed treatment C (16.42 kcal/bird/day). Feed treatments B and A produced maintenance energy respectively 27.96% and 34.75% lower (P<0.05) compared to feed treatment C. The energy for growth of joper chickens that received feed treatment D was 46.50 kcal/ birds/day. feed treatment C produces energy for growth of 41.89 kcal/bird/day which is not significantly different (P>0.05) compared to feed treatment D. Feed treatments B and A produce energy for growth respectively were 25.08% and 24.88% lower (P<0.05) compared to treatment D. The total metabolized energy requirement of joper chickens that received feed treatment D was 64.63 kcal/bird/day. and treatment C was 58. 31 kcal/bird/day. not significantly different (P>0.05) compared to feed treatment D.

Table 4. Energy balance in the body of joper chickens that received feed treatment with different energy and protein contents

Varible	Treatment				SEM
	A	B	C	D	
Gross energy consumption (kcal/bird/day)	68.87^{b}	72.42^{b}	81.01^{a}	88.46^{a}	1.73
Fecal energy (kcal/bird/day)	8.31^{a}	10.21^{a}	11.20^{a}	12.04^{a}	0.93
Metabolized energy (kcal/bird/day)	60.56^{b}	62.21^{b}	75.81^{a}	84.02^{a}	1.63
Energy Retention (kcal/bird/day)	43.66^{b}	43.55^{b}	52.36^{a}	58.12^{a}	1.24
Heat Production (kcal/bird/day)	16.90^{b}	18.66^{b}	23.45^{a}	25.90^{a}	1.02
Maintenance energy (kcal/bird/day)	11.83^{b}	13.06^{b}	16.42^{a}	18.13^{a}	0.98
Maintenance energy (kcalW$^{0.75}$/day)	16.52^{b}	17.18^{b}	19.20^{a}	21.35^{a}	1.01
Energy for growth (kcal/bird/day)	34.93^{b}	34.84^{b}	41.89^{a}	46.50^{a}	1.19
Total Energy Requirements (kcal/bird/day)	46.76^{b}	47.90^{b}	58.31^{a}	64.63^{a}	1.28
ME consumption/g growth (kcal/g growth)	0.095^{b}	0.098^{b}	0.10^{a}	0.11^{a}	0.02

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Energy Efficiency (%)	72.01[a]	70.0[a]	69.07[a]	69.19[a]	1.69

1) A: Joper chickens that receive feed treatment with a metabolized energy content of 2700 kcal/kg and crude protein 14%. B: metabolized energy content 2800 kcal/kg and crude protein 15% C: metabolized energy content 2900 kcal/kg and crude protein 16%. D: content metabolized energy 3000 kcal/kg and crude protein 17%
2) The same superscript on the same line indicates not significantly different (P>0.05) and different superscripts on the same row indicate significant differences (P<0.05)
3) SEM : *Standard Error of The Treatment Means*

Metabolized energy consumption per body weight gain of Joper chickens in treatments D and C was not significantly different (P>0.05). respectively 0.11 kcal/g body weight gain and 0.10 kcal/g body weight gain. Treatments B and A required metabolized energy per body weight gain that was 10.91% and 13.64% lower (P<0.05) than treatment D. The average gross energy consumption of joper chickens aged 0 - 8 weeks is 77.69 kcal/kg/day. The results of Candra's research (2019) resulted in the consumption of free-range chickens aged 0-8 weeks being 64.82 kcal/kg/day. The gross energy consumption of Joper chickens is higher than that of free-range chickens. because Joper chickens are a cross between male Bangkok chickens and laying hens. Joper chickens produced a weight gain of 11.69 g/bird/day. higher than the results of research by Ariesta *et a*l (2015) which obtained a weight gain of free-range chickens of 5.87 g/bird/day. Metabolized energy in joper chickens that received feed treatment D and E was higher compared to feed treatment B and A. Feed treated D and C was more palatable compared to treatment B and A. because it used less rice bran and higher palm oil so feed consumption higher. The energy content in feces and the efficiency of energy use were not significantly different between treatments. causing the energy metabolized in joper chickens given treatments D and C to be higher than those treated B and A.

Feed treatments D and C produce higher metabolized energy with energy use efficiency not being significantly different. causing the retention energy in the chicken's body in feed treatments D and C to be higher than in feed treatments B and A. Maintenance energy is the amount of energy needed by animals to carry out the body's physiology. Maintenance energy is not used for production activities such as growth. reproduction. milk production. or meat production. This energy is used for basal metabolic processes. maintaining body temperature. light physical activity. and other basic body functions. Animals that receive food with a higher energy content cause faster growth or an increase in body mass. Joper chickens with a higher final body weight in treatments D and C require higher energy for maintenance compared to feed treatments B and A. The energy used for growth in feed treatments A and B is lower than in treatments C and D. which is a logical consequence due to the increase in The body weight of joper chickens in feed treatments A and B is lower than in feed treatments C and D. The total energy requirement is the sum of maintenance energy and growth energy. so the total energy requirement of joper chickens in feed treatments D and C is higher than in treatment A and B.

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Protein Balance in the Body of Joper Chickens

Joper chickens that received feed treatment D consumed 4.95 g/day of protein. treatment C was 4.60 g/day which was statistically not significantly different (P>0.05). Joper chickens that received feed treatments B and A consumed 20.0% and 28.08% less protein (P<0.05) than treatment D. Treatment D caused the protein content in Joper chicken feces to be 0.85 g/day. treatment C was 0.82 g/day which was statistically not significantly different (P>0.05). The highest digestible protein of joper chickens given treatment D was 4.10 g/day. treatment C was 3.78 g/day which was not statistically significantly different (P>0.05). Treatments B and A produced 21.22% and 30.24% lower digested protein (P<0.05) than treatment D.

Table 5. Crude Protein balance in the body of joper chickens that received feed treatment with different energy and protein contents

Variabel	Treatment				SEM
	A	B	C	D	
Protein Consumption (g/day)	3.56 ^{b}	3.94 ^{b}	4.60 ^{a}	4.95 ^{a}	0.35
Fecal Protein (g/day)	0.69 ^{a}	0.71 ^{a}	0.82 ^{a}	0.85 ^{a}	0.08
Digestible Protein (gr/day)	2.86 ^{b}	3.23 ^{b}	3.78 ^{a}	4.10 ^{a}	0.32
Protein Retention (g/day)	2.25 ^{b}	2.54 ^{b}	3.11 ^{a}	3.84 ^{a}	0.29
Growth Protein (g/day)	1.62 ^{d}	2.13 ^{c}	2.61 ^{b}	3.07 ^{a}	0.14
Protein Maintenance (g/day)	0.63 ^{a}	0.41 ^{a}	0.50 ^{a}	0.77 ^{a}	0.06
Total Protein Requirements (g/day)	2.25^{c}	2.54^{b}	3.11 ^{a}	3.84 ^{a}	0.33
Protein Growth/weight gain (g)	0.16 ^{b}	0.19 ^{b}	0.19 ^{b}	0.23 ^{a}	0.02
Maintenane protein g/ $W^{0.75}$	0.28 ^{a}	0.17 ^{b}	0.18 ^{b}	0.29 ^{a}	0.03
Protein Efficiency (%)	78.68 ^{c}	78.64 ^{c}	82.28 ^{b}	93.66 ^{a}	1.24

1)A: Joper chickens that receive feed treatment with a metabolized energy content of 2700 kcal/kg and crude protein 14%. B: metabolized energy content 2800 kcal/kg and crude protein 15% C: metabolized energy content 2900 kcal/kg and crude protein 16%. D: content metabolized energy 3000 kcal/kg and crude protein 17%

2) The same superscript on the same line indicates not significantly different (P>0.05) and different superscripts on the same row indicate significant differences (P<0.05)

3) SEM : Standard Error of The Treatment Means

Joper chickens that received feed treatment D produced protein retention of 3.84 g/day, treatment C produced protein retention of 19.01% (P>0.05), while treatments B and A produced protein

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retention of 36.72% and 41.41. % lower (P<0.05) than treatment D. The use of protein for growth in treatment D was the highest, namely 3.07 g/day, while in treatments C, B and A 14.98%, 30.62% and 47.23% were respectively lower (P<0.05). Protein for growth per weight gain of Joper chickens was highest in treatment D, namely 0.23 g/g body weight gain, while treatments C, B, and A were 17.39%; 17.39%; 30.43% lower (P<0.05) than treatment D. The highest maintenance protein in joper chickens occurred in treatment D, namely 0.29g/W0.75, treatment A was 33.45% lower (P>0, 05), while treatments B and A were 37.93% and 41.38% lower (P<0.05) than treatment D. The protein use efficiency of Joper chickens that received feed treatment D was the highest namely 93.66%, while treatments C, B, and A produced protein efficiency of 82.28%, 78.64, and 78.68% significantly (P<0.05) lower than treatment D.

The average protein consumption of joper chickens that received treatment A, B, C, and D was 4.26 g/day. The results of this study are not much different from the results of research by Ariesta et al (2015) which found that the average consumption of native chicken protein was 4.23 g/day. The digestible protein of joper chickens that received feed treatments D and C was higher than treatments B and A. Fecal protein of joper chickens did not differ between feed treatments, so that higher protein consumption in treatments D and C resulted in higher protein digestibility compared to treatments B and A.

Feed treatments D and C resulted in higher protein retention than treatments B and A. This condition was caused by the higher feed consumption of joper chickens that received feed treatments D and C. The protein content of the feed in treatments D and C was also higher so that the total protein intake was higher. Protein intake was higher in feed treatments D and C with higher protein efficiency so that the protein retained in chickens treated with D and C was higher than in treatments B and A. Growth protein received in feed treatments A and B was lower than in treatments C and D. This was due to the increase in body weight of Joper chickens in feed treatments B (636.71 g) and A (582.33 g) lower than D (745.38 g) and C (751.70 g).

Feed treatments D and A require higher maintenance protein per metabolic body weight (W0.75) than treatments C and B. The protein consumed by animals is converted into amino acids, which are used for various body functions, including growth, tissue repair, and enzyme production. The research results indicate that there is an excess of protein, after it is used to form body tissue. When protein consumption is higher than necessary, the body needs to maintain a greater nitrogen balance. Unused protein is converted to urea and excreted, increasing the metabolic need to process this protein. High protein consumption often accelerates the protein turnover process in the body, namely the process of breaking down and resynthesizing proteins. This increases the need for protein to maintain normal body function because more protein must be broken down and replaced on a regular basis. This condition causes the protein requirement for maintenance in feed treatments D and A to be higher than in feed treatments B and C.

The total protein requirement for Joper chickens is the sum of growth protein requirements and maintenance protein requirements. Joper chickens that received feed treatment D and C were higher than those treated B and A. This condition was caused by the weight gain of Joper chickens aged 0-8 weeks in treatment D and C being higher than treatment A and B. The protein consumed by the animals

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was components needed in the formation of meat in animals (Nuriyasa *et al,* 2018).

Calculation of Energy and Protein Requirements for Joper Chickens

The average energy requirement for joper chickens is 54.40 kcal/kg and protein requirement is 2.94 g/day. Joper chicken feed consumption is 20.48 g/bird/feeding day. Based on calculations, the metabolized energy content in Joper chicken feed is 2656.25 kcal/kg and the crude protein content in Joper chicken feed is 14.36%.

Conclusion

Feed treatment for Joper chickens with different metabolized energy and crude protein content has no effect on the microclimate of the cage. Joper chickens raised in tropical lowland areas require feed with a metabolizable energy content of 2656.25 kcal/kg and crude protein of 14.36%.

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Authors Contribution

IMN, IAAP and AAPPW designed, executed the research, and wrote the manuscript. IKP all authors contributed equally to the writing of the final manuscript.

Conflict of Interest

The author declares no potential conflict of interest in this researc

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