Influence of Dietaryprotein and Energy Levels on Performance, Meat: Bone Ratio, and Meat Chemical Composition of SenSi-1 Agrinak Chickens

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ABSTRAK

Hidayat C, Iskandar S. 2019. Pengaruh kandungan protein dan energi metabolis ransum terhadap kinerja produksi, rasio daging terhadap tulang dan komposisi kimia daging ayam SenSi-1 Agrinak. JITV 24(1): 1-8. DOI: http://dx.doi.org/10.14334/jitv.v24i1.1913

Sensi-1 Agrinak merupakan hasil pemuliaan dari salah satu jenis ayam lokal di Indonesia untuk produksi daging. Tujuan dari penelitian ini adalah untuk mengetahui pengaruh tingkat energi metabolis dan protein dalam ransum terhadap kinerja produksi, rasio daging terhadap tulang, dan komposisi kimia daging ayam SenSi-1 Agrinak yang dipelihara sampai umur 10 minggu. Dua ratus enam belas *unsexed* DOC Sensi-1 Agrinak diberi enam ransum perlakuan dengan kandungan protein kasar (PK) (21,19 dan 17%), serta kandungan energi metabolis (EM) (2800 dan 3000 kkal/kg). Setiap kombinasi perlakuan diulang sebanyak empat kali. Dalam setiap kombinasi perlakuan ada sembilan unsexed-DOC. Parameter yang diamati adalah kinerja produksi (Bobot hidup, konsumsi ransum, viabilitas, FCR), indeks ekonomi (EPEF), rasio daging terhadap tulang, dan komposisi kimia daging. Hasil penelitian menunjukkan bahwa peningkatan kandungan PK ransum meningkatkan bobot hidup dan EPEF (P<0,05). Ayam Sensi-1 Agrinak memiliki FCR terbaik (2,59), ketika diberi pakan yang mengandung 21% PK dan 3000 kkal/kg. Peningkatan kandungan PK ransum dapat meningkatkan rasio daging terhadap tulang pada potongan karkas bagian dada, paha atas, dan paha bawah. Sementara itu, peningkatan kandungan PK dan EM ransum tidak mempengaruhi (P>0,05) komposisi kimia daging. Dapat disimpulkan bahwa kadar protein kasar dan energi metabolis yang optimal untuk ayam Sensi-1 Agrinak untuk masa pemeliharaan 0-10 minggu adalah 21% PK dan 3000 kkal/kg.

Kata Kunci: Energi Metabolis, Protein, Ayam Sensi-1 Agrinak

ABSTRACT

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Sensi-1 Agrinak is a strain of the improved native chickens for meat production in Indonesia. The objective of this study was to investigate influence of different dietary energy and protein levels on performance, meat bone ratio, and meat chemical composition of Sensi-1 Agrinak chicken, reared until 10 weeks of age. Two hundred and sixteen of unsexed day old chickens (DOC) of Sensi-1 Agrinak were subjected to six experimental rations differed in dietary crude protein (CP) content,. Namely: 21;19; and 17 % and dietary metabolizable energy (ME) (2800 and 3000 kcal/kg). Each treatment combination was replicated four times and fed from day old to 10 weeks old. In each treatment combination there were nine unsexed-DOCs. The parameters observed were performance (i.e. live weight, feed intake, viability, FCR), economic index (European Production Efficiency Factor/EPEF), meat bone ratio, and meat chemical composition. Result showed that increased of dietary CP level increased live weight and EPEF (P<0.05). Sensi-1 Agrinak chicken had the best FCR (2.59), when fed diet containing 21% CP and 3000 kcal/kg. Increased dietary CP level increased the meat-bone ratio of breast, thighs, and drumsticks. Meanwhile, increased levels of dietary CP and ME did not affect (P>0.05) meat chemical composition. It is concluded that optimal dietary levels of crude protein and energy for unsexed Sensi-1 Agrinak chicken up to 10 weeks of age were 21% CP and 3000 kcal/kg.

Key Words: Dietary Metabolizable Energy, Dietary Protein, Sensi-1 Agrinak Chicken

INTRODUCTION

Improving and developing Indonesian native chicken has been continued done by the Indonesian government in order to increase the contribution of native chicken to the national poultry meat. Supported by the general view of the Indonesian people who generally consider that native chicken meat is more delicious than the broiler chicken meat, as indicated by the price of native chicken meat is more expensive. There is a significant potential in developing native chicken in Indonesian livestock industry Chen et al. (2008) stated that generally, native chicken meat has intense flavour, firm texture, low fat content and rich in other nutrients. One of the improved strains of native chicken in Indonesia as a meat producer is Sensi-1

Agrinak chicken. The Sensi-1 Agrinak chicken was selected for optimum growth of market demand, by the average live weight of 1 kg per bird at 10 weeks of age (Hasnelly et al. 2017). Nonetheless, information of the influence of dietary protein nor energy on the performance of Sensi-1 Agrinak chicken has not yet reported.

Niu et al. (2009) stated that energy and protein were the main nutrients with the highest economic value compared to other nutrients. Energy is needed by animals to support all of their activities. Meanwhile, protein is a key component of cells that plays an important role in the life process. Accordingly, optimal chicken production requires an appropriate combination of dietary metabolizable energy (ME) and crude protein (CP). This is to ensure maximum utilization of each and every nutrient of the diet and help to reduce the cost of production (Zaman et al. 2008). One method of determining protein requirements and ration energy in local chickens is through feeding trial testing using several treatment diets varying protein and energy content. As was done by Magala et al (2012) in uganda local chickens, using several experimental diets varying 18-20% crude protein and 2800-3000 kcal metabolizable energy content per kg. Meanwhile, Hidayat et al. (2017) used diet varying 17-19% CP and 2800-3100 kcal ME/kg to determin the most efficient diet to an improved breed of Indonesian native chicken. The nutritional content of the feed greatly influenced the quality of chicken meat (Marcu et al. 2011a). Marcu et al. (2011b) explained that the quality of chicken carcass was determined by the maximum proportion of meat and the minimum proportion of bone in the carcass cut. Meanwhile, the main chemical components of meat (protein, fat) are important indicators in determining meat quality (Diaz et al. 2010). The objective of the current study was to investigate the effect of feed with different energy and protein levels on the performance, meat bone ratio, and meat chemical composition of Sensi-1 Agrinak chickens reared to 10 weeks of age.

MATERIALS AND METHODS

Two hundred and sixteen of unsexed DOCs of Sensi-1 Agrinak chicken were subjected to six experimental diets, differed in combination of dietary crude protein (CP) (21, 19, and 17%) and dietary ME 2800 and 3000 kcal/kg. Each treatment combination was replicated four times, arranged in a (3 x 2) completely factorial design. In each treatment combination there were nine unsexed DOCs, randomly picked and confined in a colony wire cage with floor space of 35 x 35 cm and height of 40 cm. Heating light bulb was constructed to provide proper heat during brooding age. Feed in mash form and drinking water were provided *ad libitum*.

Health programs such vaccination with proper vaccines and cage sanitation were applied following the programs that usually applied to exotic broiler chicken breed. Immunization program consisted of: i) Against NDIB (new castle disease and infectious bronchitis) at four days of age ; ii) Against IBD (gumboro) at seven days old; iii) The IBD vaccine was repeated in day 21; iv) ND-IB was repeated at the age of 28 days. Feed composition and nutrients content of the experimental diets are presented in Table 1.

Live weight and feed intake were measured every week. Mortality was recorded at any time when the loss happened. At the age of ten weeks, one male and one female from each replication were taken randomly for carcass and carcass cuts analysis. Slaughter process was applying the Islamic slaughter method (Hafiz et al. 2015). Feed conversion ratio was calculated by feed consumed divided by the total live weight gain of bird (g feed consumption/ g live weight gain). European Production Efficiency Factor (EPEF) was calculated using this formula (Marcu et al. 2013):

$$\text{EPEF} = \frac{\text{Viability (\%) x Live Weight (kg)}}{\text{Age (day) x FCR}} \text{ x } 100$$

Viability	: Percent of the number of chickens that live in each replication
Live weight	: Live weight at the time of measurement (g/bird)
Age	: Age at the time of observation is stopped (day)
FCR	: Feed Conversion Ratio

Fresh meat bones ratio was calculated in grams meat per one gram bone (Marcu et al. 2013), using the formula below :

Fresh meat: bones ratio (g meat : 1 g bone) = meat weight / bones weight

After deboning, laboratory analysis for chemical composition of meat (moistures, proteins, lipids, and cholesterols) was carried out at the accredited laboratory in the Indonesian Research Institute for Animal Production (IRIAP) of the Indonesian Agency for Agricultural Reseach and Development (IAARD) Ministry of Agriculture. The raw data were processed using methods of biostatistics with Microsoft Excel spreadsheet application. Analysis of variance (ANOVA) of SAS 9.13 statistical program was used to test the statistical significance of differences among treatment mean values.

Table 1. Feed composition and nutrients content of experimental diets fed to SenSi-1 Agrinak chicken up to 10 weeks of age

Feedstuffs	21%CP		19%CP		17%CP	
	3000 kcal ME/kg	2800 kcal ME/kg	3000 kcal ME/kg	2800 kcal ME/kg	3000 kcal ME/kg	2800 kcal ME/kg
Corn, (%)	38.65	37.65	31	38	30.6	44
Rice bran, (%)	23.5	27.5	39.43	33.15	45	32.65
Soybean meal, (%)	30	23.5	20.72	14	13.75	6
Meat bone meal, (%)	3	8.5	5	12	6.8	15
Vegetable oil, (%)	3	0.5	2	0.5	2	0.5
CaCO3, (%)	0.7	1.2	0.7	1.2	0.7	0.7
NaCl (%)	0.5	0.5	0.5	0.5	0.5	0.5
Vitamin premix, (%)	0.15	0.15	0.15	0.15	0.15	0.15
Mineral premix, (%)	0.15	0.15	0.15	0.15	0.15	0.15
Lysine, (%)	0.15	0.15	0.15	0.15	0.15	0.15
Choline clorida, (%)	0.1	0.1	0.1	0.1	0.1	0.1
Sodium bicarbonate, (%)	0.1	0.1	0.1	0.1	0.1	0.1
Total, (%)	100	100	100	100	100	100
Nutrient content						
Protein, (%)*	21	21	19	19	17	17
Metabolizable Energy/ME, (kcal/kg)**	3054	2891	3050	2890	3057	2875
Ratio ME:Protein	145	137	160	152	179	169
Moisture, (%)***	10.51	10.79	10.54	9.62	9.75	9.89
Crude Fibre, (%)***	4.04	4.42	4.79	4.38	4.28	3.73
Abu, (%)***	8.77	8.74	8.16	10.61	9.17	9.86
Calcium, (%)***	1.33	1.22	0.86	1.66	0.97	1.62
Phosphor, (%)***	1.06	0.97	0.93	1.24	1.17	1.19
Amino acid content***						
Asparagine, (%)	2.56	2	2.03	1.7	1.67	1.36
Serine, (%)	1.04	0.85	0.87	0.86	0.74	0.68
Glutamine, (%)	4.29	3.38	3.41	2.94	2.83	2.57
Glycine, (%)	1.2	1.17	1.16	1.84	1.08	1.57
Histidine, (%)	0.62	0.49	0.5	0.45	0.45	0.4
Arginine, (%)	1.67	1.4	1.4	1.37	1.23	1.26
Threonine, (%)	0.91	0.73	0.75	0.68	0.65	0.58
Alanine, (%)	1.24	1.07	1.14	1.16	1	1.12
Proline, (%)	1.41	1.23	1.26	1.32	1.1	1.31
Cystein, (%)	0.17	0.13	0.16	0.12	0.13	0.12
Tyrosine, (%)	0.67	0.56	0.55	0.55	0.46	0.44
Valine, (%)	1.24	0.99	1.07	0.93	0.9	0.84
Methionine, (%)	0.29	0.22	0.25	0.25	0.21	0.21
Lysine, (%)	1.57	1.25	1.34	1.09	1.07	0.85
Isoleucine, (%)	1.01	0.79	0.81	0.67	0.67	0.57
Leucine, (%)	1.97	1.57	1.66	1.43	1.41	1.33
Phenylalanine, (%)	1.12	0.91	0.89	0.8	0.8	0.72

* Calculated based on crude protein content obtained from proximate analysis in the laboratory of feedstuffs used

** Calculated based on estimates of the metabolizable energy content of the used feedstuffs with the calculation of gross energy x 0.725 (NRC 1994)

*** Analysis results in the laboratory

RESULTS AND DISCUSSION

Performance responses of live weight, feed consumption, viability, and European Production Efficiency Factor (EPEF) were presented in Table 2. ANOVA results on these variables did not show any significant interaction effect (P>0.05). Therefore the comparissons were applied separately for each treatment factors.

Sensi-1 Agrinak chicken live weight, feed intake, viability and European Production Efficiency Factor (EPEF) were not influenced by metabolizable energy (ME) level of feed during whole experimental period (P<0.05). Meanwhile, increasing dietary CP levels increased live weight and EPEF (P<0.05), but did not affect feed intake and the viability. These findings were in line with those presented by Liu et al. (2015) who reported that there was an increase in live weight of Chinese indigenous chicken (Lueyang Black-boned Chickens), due to an increase in dietary CP levels. This results may have indicated that the dietary ME of 2800 kcal/kg has fulfilled the dietary energy requirements of Sensi-1 Agrinak chicken reared up to 10 weeks of age.

Feed whith feed contained 21% CP significantly (P<0.05) resulted in the highest live weight (897 g/bird) and the EPEF (462). Therefore, Sensi-1 Agrinak chicken looks more precise and more economical to be fed with high CP content (21%), as seen from the highest achievement on live weight and EPEF compared to the other dietary protein treatments. Results in the present study was also similar to Nguyen et al. (2010) who reported that increased dietary CP content (15 to 21%) resulted in an improvement of growth performance of Thailand indegenous chicken (Betong chicken). Dewi et al. (2015) explained that increased dietary CP level would increase the protein retention, hence, increasing growth. This was due to the increasing number of proteins that would be used to prepare the chicken body tissues. The range of ME content (at 2800-3000 Kal/kg) and CP contents (at 17%, 19.21%) in the feed did not affect the viability level of Sensi-1 Agrinak chickens. The present study showed that the feed with low dietary protein content (17%) was considerably safe for Sensi-1 Agrinak chicken until 10 weeks age resulted in viability of more than 95%.

Feed intake of Sensi-1 Agrinak chickens up to 10 weeks of age was not influenced by the dietary ME and CP level. This is in agreement with findings of Raphulu & Rensburg (2018) who also reported no differences in feed intake of South Africa indigenous chicken (Venda village chickens) with varying ME (11;11.7;12 MJ/kg) and CP levels (14;17;19%). Contrastly, Banerjee et al. (2013) reported that increased levels of protein of feed increased the level of feed intake of other South Africa indigenous chicken (Koekoek chickens). Raphulu & Rensburg (2018) stated that the effect of dietary protein on feed intake in poultry species was inconsistent due to great variation in body weight, age, genotype, sex, and stage of maturity among native chickens.

Effect of dietary treatments on FCR, efficiency of dietary CP consumption (Table 3) showed that, there was significant interactions (P<0.05) between dietary CP and ME. The FCR of Sensi-1 Agrinak chicken was

Table 2. Live weight, feed consumption, viability, and European Production Efficiency Factor (EPEF) of Sensi-1 Agrinak chicken given experimental diets up to 10 weeks of age

Factors	Live weight (g/bird)	Feed intake (g/bird	Viability (%)	EPEF
Metabolizable Energy (ME)				
2800 kcal/kg	838[a]	2335[a]	95.41[a]	396[a]
3000 kcal/kg	847[a]	2280[a]	98.16[a]	428[a]
Pooled SE	29.83	45.06	2.92	28.5
Crude Protein (CP)				
17%	805[a]	2261[a]	97.25[a]	385[a]
19%	825[a]	2311[a]	95.87[a]	390[a]
21%	897[b]	2350[a]	97.25[a]	462[b]
Pooled SE	38.69	64.97	4.50	38.95
Interaction				
ME x CP	NS	NS	NS	NS

Values in the same column and factor, with different superscript are significantly different (P<0.05)
Pooled SE = Pooled Standard Error
NS = Not statistically significant (P>0.05)

the best FCR (2.59), when given feed with high ME (3000 kcal/kg) and high CP (21%). However, when the ME of the diet was low (2800 kcal/kg), there was no significant (P>0.05) effect of protein levels on FCR. When the efficiency of dietary protein consumption was calculated, the diet with 17% protein gave the best (64%) efficiency, although it was not in agreement with the efficiency of energy consumption, which was the lowest (9.08 kcal/g LWG). The treatment which resulted in the best FCR (treatment with 21% CP and 3000 kcal/kg), was suspected to be caused by the best utilization efficiency of dietary ME (7.76 kcal/g LWG). On the contrary, combination of 17%CP and 3000 kcal ME/kg gave the low FCR (2.99 g feed/g LWG). This study seemed somehow in harmony with the research reported by Magala et al. (2012), showing that cockerels fed the low-protein and metabolizable energy diet (18% CP and 2800 kcal/kg) would respon in superior protein efficiency ratio in comparison to that of chicken fed on the high-protein and metabolizable energy diet (20% CP and 3000 kcal/kg).

Eventually, these results indicated that Sensi-1 Agrinak chicken showed the ability to convert feed to meat better when fed with high nutrient density feed.

There was no significant (P>0.05) interaction between CP and ME on meat : bone ratio of the breast, thighs, and drumsticks of Sensi-1 agrinak chicken (Table 4).

Breast, thighs, and drumsticks are the most valuable chicken carcass cuts in the Indonesian market, even small differences in price of the three carcass cuts above, it can have significant economic impact. Globally, the breast, thighs, and drumsticks, were widely used as an indicator of the quality of carcasses in meat chickens (Marcu et al. 2013). The higher meat : bone ratio has a meaning of a higher chicken carcass quality, which shows the higher proportion of meat of the whole carcass. Meat : bone ratio of breast, thighs, and drumstick did not affected by increasing dietary ME level. Meanwhile, an increase in dietary CP level increased the meat : bone ratio in the three carcass cuts (breast, thighs, drumsticks) as shown in Table 5. This result showed that higher dietary CP caused high CP consumed, and eventually increased the protein retention to be converted to body flesh .

There was no significant (P>0.05) interaction effect between dietary CP and dietary ME on the meat chemical compositions parameters (moisture, protein, fat, cholesterol) of Sensi-1 Agrinak chicken (Table 5). This finding was different from report of Marcu et al. (2012), who explained that dietary nutrition was an external factor as a major influence on the chemical composition of chicken meat. Previously, Bogosavljevi-Bošković et al. (2010) also reported that the chemical composition of chicken carcass cuts were influenced by genetic and non-genetic factors.

The current study showed that the protein and fat content of Sensi-1 Agrinak chicken meat was consistent with that reported by several researchers that the protein and fat content of meat chicken was above 22.50% CP and below 3% fat (Marcu et al. 2011b; 2009; Horniakova et al. 2009). The cholesterol content of Sensi-1 Agrinak chicken meat was not affected by dietary CP and ME levels. The current study was in tune with the result of study which shown by Maliwan et al. (2017) in Thai indigenous crossbred chicken (Korat chicken) which reported that the feeding program was given different dietary CP levels (15,17,19,21% CP) during the growth period (0-10 weeks), affected no different meat chemical composition (moisture, protein, and cholesterol). Brewer et al. (2012) reported that studies which had been done to attempt with several feeding programmes using many dietary CP levels, showed that all the programs did not affect meat quality. The present study showed that the content of fat at Sensi-1 Agrinak chicken meat was lower than the fat content of broiler chicken meat as reported by Hasanuddin et al. (2013), who showed that the fat content of broiler chickens meat was in the range of 4.88-7.38%. Contrastly, the content of cholesterol at Sensi-1 Agrinak chicken meat was higher than the content of cholesterol of broiler chickens meat,i.e., in the range of 0.046 – 0.049% (Abdulla et al. 2015).

Table 3. Feed Conversion Ratio (FCR), and efficiency of dietary crude protein and dietary metabolizable energy consumptions of Sensi-1 Agrinak chicken given experimental diets up to 10 weeks of age

Variable	3000 kcal ME/kg			2800 kcal ME/kg			SEM
	21% CP	19% CP	17% CP	21% CP	19% CP	17% CP	
FCR (g feed/g LWG)	2.59^{a}	2.83^{b}	2.99^{b}	2.84^{b}	2.99^{b}	2.86^{b}	0.043
Efficiency of crude protein consumption, (g/g LWG)	0.54^{bc}	0.54^{bc}	0.50^{a}	0.64^{d}	0.56^{c}	0.50^{ab}	0.010
Efficiency of ME consumption, (kcal/g LWG)	7.76^{a}	8.61^{bc}	9.08^{c}	8.25^{ab}	8.89^{c}	8.20^{ab}	0.117

SEM = Standar error of mean
LWG = Live wight gain
Values in the same row with different superscript are significantly different (P<0.05)

Table 4. Meat bone ratio on breast, thighs, and drumsticks of 10 weeks old unsexed Sensi-1 Agrinak chicken given experimental diets

Factors	Breast	Thighs	Drumsticks
Metabolizable Energy (ME)			
2800 kcal/kg	4.40[a]	5.29[a]	3.00[a]
3000 kcal/kg	4.88[a]	4.72[b]	2.85[a]
Pooled SE	0.425	0.239	0.135
Crude Protein (CP)			
17%	3.97[b]	4.72[b]	2.90[ab]
19%	4.46[b]	4.93[ab]	2.79[b]
21%	5.49[a]	5.36[a]	3.09[a]
Pooled SE	0.44	0.30	0.16
Interaction			
ME x CP	NS	NS	NS

Values in the same column and factor, with different superscript are significantly different (P<0.05)
Pooled SE = Pooled Standard Error
NS = Not statistically different (P>0.05)

Table 5. Chemical composition *(as is)* of meat of 10 weeks age-old of Sensi-1 Agrinak chicken fed experimental diets

Factors	Moisture (%)	Protein (%)	Fat (%)	Cholesterol (%)
Metabolizable Energy (ME)				
2800 kcal/kg	74.05[a]	24.24[a]	1.97[a]	0.16[a]
3000 kcal/kg	74.12[a]	24.15[a]	2.31[a]	0.17[a]
Pooled SE	0.31	0.53	0.26	0.01
Crude Protein (CP)				
17%	73.60[b]	24.19[a]	1.83[a]	0.15[a]
19%	74.08[ab]	24.32[a]	2.23[a]	0.18[a]
21%	74.57[a]	24.07[a]	2.36[a]	0.18[a]
Pooled SE	0.38	0.75	0.40	0.01
Interaction				
ME x CP	NS	NS	NS	NS

Values in the same column and factor, with different superscript are significantly different (P<0.05)
Pooled SE = Pooled Standard Error
NS = Not statistically different (P>0.05)

The current study showed that the protein and fat content of Sensi-1 Agrinak chicken meat was consistent with that reported by several researchers that the protein and fat content of meat chicken was above 22.50% CP and below 3% fat (Marcu et al. 2011b; Marcu et al. 2009; Horniakova et al. 2009). The cholesterol content of Sensi-1 Agrinak chicken meat was not affected by dietary CP and ME levels. The current study was in tune with the result of study which shown by Maliwan et al. (2017) in Thai indigenous crossbred chicken (Korat chicken) which reported that the feeding program was given different dietary CP levels (15,17,19,21% CP) during the growth period (0-10 weeks), affected no different meat chemical composition (moisture, protein, and cholesterol). Brewer et al. (2012) reported that studies which had been done to attempt with several feeding programmes using many dietary CP levels, showed that all the programs did not affect meat quality. The present study showed that the content of fat at Sensi-1 Agrinak chicken meat was lower than the fat content of broiler chicken meat as reported by Hasanuddin et al. (2013), who showed that the fat content of broiler chickens meat was in the range of 4.88-7.38%. Contrastly, the content of cholesterol at Sensi-1 Agrinak chicken meat was higher than the content of cholesterol of broiler chickens meat,i.e., in the range of 0.046 – 0.049% (Abdulla et al. 2015)

CONCLUSION

Taking the performance, economic index aspect, meat bone ratio, and meat chemical composition traits of Sensi-1 Agrinak chicken into account, it is concluded that optimal dietary levels of crude protein and metabolizable energy for Sensi-1 Agrinak chicken was 21% CP and 3000 kcal ME/kg feed from 0-10 weeks of age.

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