

Effect of level of metabolizable energy on the breast and wing weight of local chickens: A meta-analysis

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Abstract. The purposed of this study was to determine the effect of dietary energy and protein balance on the wing weight and breast weight of native chicken using meta-analysis technique. This study used meta-analysis technique to integrate 116 data from 8 articles that contain information about effect of energy and protein balance rations on wings weight and breast weight of local chicken. The meta-analysis technique begins with collecting data from several scientific publications that contain energy and protein levels. The data was tabulated in the form of database with the help of Microsoft excel and in this tabulation process the units of each data were equalized tabulated and analysed using SAS. The results of this study concluded that it took 17.04% of dietary crude protein to produce a minimum breast weight of 151.96grams and 2953.31 kcal/kg to produce 122.66grams of breast weight, as well as 17.43% of raw proteins to make a minimum wing weight of 88.25gram and 2970 kcal / kg to produce an 89.53gram of wing. In conclusion protein requirements and energy metabolism, each pile showed varying results. The existence of this diversity is influenced by genetic and environmental factors.

1 Introduction

The diversity of local chicken varieties in Indonesia is large. Indonesia has 31 local chicken groups, both native and introduced chickens that have undergone adaptation for decades or even hundreds of years. These local chickens are scattered all over the Nusantara region and serve the purpose of supplying village chicken meat, eggs, and companion animals [1]. Examples of local indigenous chickens are KUB chickens, Pelung chickens, Bekisar chickens, Kedu chickens, and Kate chickens. Some of these chickens are kept as pets and as favorite collections of enthusiasts because of the beauty of appearance, feathers, and their gentle voice.

The existence of diverse local chicken varieties encourages many farmers to raise and produce them for the production of meat and eggs which are highly in demand, as these products are known to be organically produced and possess certain flavours and highly in demand in niche market. Local chicken meat and eggs have unique characteristics and

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flavours that are of great interest to the community. Besides, the abundance of Nusantara cuisines that use local chicken as their main ingredient, but the production of meat and eggs is limited and insufficient to meet market demands.

The development potential of this local chicken is hampered by its low productivity and poor growth rates. It's because of its longer growth than the commercial breeds. Improving local chicken productivity can be achieved by improving the management, supply, and quality of feed [2].

One of the important nutrients that local chickens need during growth is protein and metabolic energy. This is because the energy and protein of the feed are the main components that the poultry need to live and produce. Both components must be considered together in the preparation of the feed or, in other words, each energy and protein of the rotting have different levels of influence on growth and fatigue [3]. Research on feeding with protein and metabolic energy in various local chicken flocks has been extensive. The results obtained are also very varied and so far there is no data on the exact value of these two nutrients in particular that are needed by local chickens. That's why we need techniques to analyze and draw conclusions from existing data to address these differences. One method of answering the value of such nutrients is by using meta-analysis statistical techniques. This technique is a tool to integrate data from each choice made at different places, times, and researchers, but still with the same variable. Besides, the data used also has some consistency such as treatment, object, and so on [4].

The use of meta-analysis in poultry research can improve the power and precision of statistics as well as generate new hypotheses. Thus, through meta-analysis precise values of the amount of protein and metabolizable energy required by various local chicken varieties can be obtained based on several studies previously investigated. This study aims to determine the amount of protein and metabolizable energy needed by some native chickens in relation to the breast and wing weight of the carcass, through a meta-analysis approach.

2 Material and method

2.1 Materials

Data from several national and international journals that published research papers related to the influence of protein and metabolic energy levels in feed on breast and wing percentages in three local chicken varieties, namely Pelung x Native cross, Native chicken, and Jowo Persilangan chicken.

The database was compiled from several national and international articles published using searches such as Scopus, ScienceDirect, and Google Scholar, with keywords, native chicken, protein, metabolic energy, breast weight, and wing weight. The data collected from various subsequent articles were stored in a Microsoft Excel-based database. The tabulation was done by harmonizing the units and weighing data such as protein usage and metabolic energy as well as the variables studied as the weight of breast and wings. A total of relevant 116 data sets from eight articles were collected and used in the analyses.

The meta-analysis was conducted on data from published research articles that used proteins and metabolizable energy values that were predominantly from the local feed. The selected article lists the protein content and metabolizable energy derived from laboratory tests so that the data processed were valid. Protein levels and metabolizable energy in this study were used as continuous variables, while the percentage of breast and wing reported in the papers as response variables. The diagram flow of article selection in the meta-analysis using the SYRCLE method will result in the figure below.

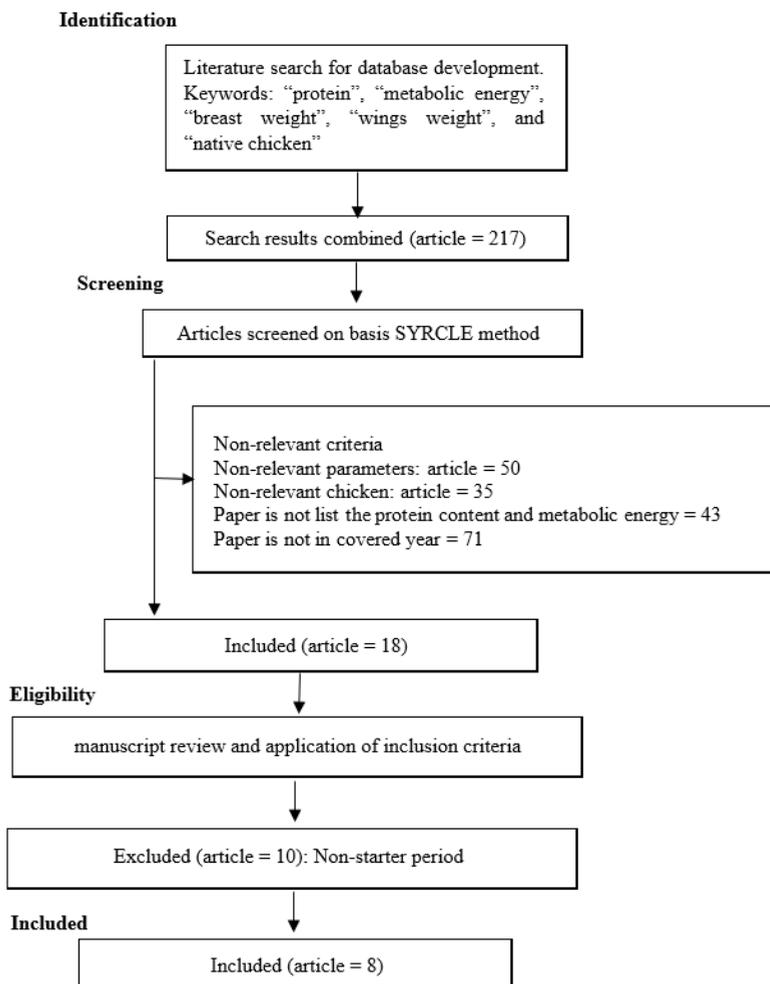


Fig. 1. Diagram flow of article selection in the meta-analysis using SYRCLE method (Sholikin et al., 2023)

Table 1. Studies included in the meta-analysis of the prediction of protein requirements and energy metabolic on breast weight and wings weight

No	References	year	Source of CP and ME	CP Level	ME Level	Phenotype
1	Iskandar <i>et al.</i>	1998	Local feed + pollard	15.00-21.00	-	Pelung x Native
2	Ramdani <i>et al.</i>	2016	Coconut pulp meal	12.93-21.50	-	Native chicken
3	Sari <i>et al.</i>	2016	Soybean hall meal	13.66-20.05	-	Native chicken
4	Yuniza <i>et al.</i>	2011	Local feed with lisin	14.48	2903,9-2907,25	Native chicken
5	Iskandar	2006	Local feed	14.00-19.00	-	Pelung x Native
6	Ariawan <i>et al.</i>	2016	Papaya leaf powder	18.58	2985	Native chicken
7	Narayana <i>et al.</i>	2022	Bakery waste	18.38-18.63	2941-2995	Jowo Persilangan
8	Leke <i>et al.</i>	2015	Local feed + fish oil	14.66-20.46	2820,12-2988	Native chicken

CP: crude protein; ME: metabolizable energy

2.2 Data analysis

Statistical analysis designs used in the study of protein and energy balances for determining nutrition require a statistical model design [5], with a meta-analysis approach [6], as well as the SAS 2022 mixed model procedure. In this study model mixing procedures were used to combine fixed-effect methods and random effects. This combination was expected to reduce bias or too high an error. This excessive bias generally arises as a result of meta-analysis techniques in cattle using fixed-effect methods. This method only focussed on the probability value so the bias caused by the research variation was not taken into account, so the resulting bias is too high, on the other hand, there is a method that is able to analyze the variation present in the meta-analysis data, this method is called the random effect. Random effect methods not only concentrate on intra-study data but also take into account differences between studies. In fact, the difference between the resulting fixed effect and the random effect was not too high on homogeneous data, but when the data used was heterogenous then there was a high difference, therefore it is necessary to have a method capable of combining the two methods, this method is called a mixed model method. The statistical analysis model used from the mixed model in this study was as follows:

$$Y_{ij} = B_0 + B_1X_{ij} + B_2X_{ij}^2 + s_i + b_iX_{ij} + e_{ij} \quad (1)$$

Where Y_{ij} = the expected result or the bound variable observed at the level j of the variable X , the X free variable is continuously in accordance with the study i ; B_0 = the total intercept of all experiments; B_1 = the linear regression coefficient Y on X (fixed effect); B_2 = the quadratic coefficient of regression Y on the X (random effect); X_{ij} = the synthetic date of the value j of X continuous variable in the research i ; s_i = the random effect of study I ; b_i = the accidental effect of study i on the regression factor Y based on X ; e_{ij} = overall research error.

3 Results and discussion

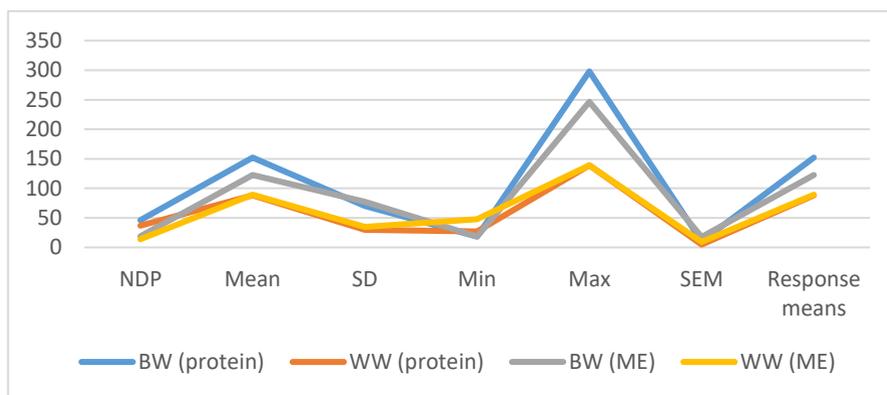
3.1 Descriptive formula model for protein and energy metabolic

The calculation of the model was done using XLSTAT. This calculation was conducted with the aim of knowing the formula so that the amount of protein and the metabolizable energy can be obtained. The calculation of a formula involving 8 articles with 116 data was done using a linear regression formula. The equation obtained using this linear regression analysis resulted in the model shown in the table below.

Table 2. Formula model for protein and energy metabolic to produce breast weight and wing weight

Variable	Breast weight formula model	Wings weight formula model
Crude Protein	15.7066+(0.0088 x Response means)	17.13363+(0.00332 x Response means)
Metabolic Energy	2923.8528+(0.24014x Response means)	2980.5996-(0.1184 x Response means)

In addition to calculating the formula model, we also conducted an analysis involving all data from the publications to find out the optimization values of breast weight and wing weight on various local chicken flocks. The diversity of data contained in the article makes the spread point and generates the size done using SAS 2022. The results of data analysis on protein and metabolic energy with variables of breast weight and wing weight can be seen in the following graph.



BW: breast weight; WW: wing weight; ME: Metabolizable energy

Fig. 2. Descriptive statistics of the effect different source of protein and metabolic energy

After obtaining the optimal point on each treatment on both breast weight and wing weight, the alignment was carried out using the model formula contained in Table 1. The calculation is done with the aim of acquiring protein and metabolic energy requirements in accordance with the optimal value of the results. The results of calculations using the formula model on both protein and metabolizable energy can be seen in Table 4 below.

Table 3. Prediction of protein and metabolizable energy requirement to produce breast weight and wing weight

Treatment	Protein need (%)	Metabolic energy needs (kcal/kg)
Breast Weight	17.04	2953
Wings Weight	17.43	2970

Based on the calculations that have been made, the protein and metabolizable energy requirements for breast weight and wing weight were 17.04% and 17.43% respectively as well as 2953.31 kcal/kg and 2970 kcal/kg. Through the amount of protein and the energy of the metabolism, it is expected to produce breast weight and wing weight according to the optimal response means or point produced. For example, the use of proteins with a percentage of 17.04% is expected to produce a minimum breast weight of 151.96 grams. The size of the protein and metabolizable energy requirements is similar to the study before [7] which gave the protein percentages of 17% and produced a breast weight of 196 grams, as well as lower than the research before [8] which provided the protein of 17.66% and generated the breast mass of 298grams and the wing weight of 31grams. In terms of the volume of metabolic energy, the results of this study are almost similar to those of previous studies [9] which showed that metabolizable energy of 2959 kcal/kg and 2969 kcal /kg, resulted in 218.48 grams of breast weight and wing weight of 131.86 grams.

To date, the preparation of local chicken rations used by Indonesia is still based on recommendations from the research before [10] and breeding chicken standards [11]. The metabolic energy requirements of mild chickens aged 2-8 weeks are between 2600-3100 kcal/kg and protein between feeding 18%-24%, the metabolic energy and protein requirements are 2900 kcal / kg and 18%, respectively, but these standards are not protein and energy requirements for local chicks bred in tropical climates such as Indonesia [12]. So

the amount of protein and the energy of metabolism on the results of this study can be considered as a prediction as the values were derived from data analysis based on many previous studies.

The need for protein to produce breast weight and wing weight must be observed. This is because protein is a nutrient that is needed for tissue development and composition as well as repair [13] ; [14]. The use of protein levels in feeding would affect the increase in chicken body weight. This is because feeding with low protein levels can not support maximum weight gain due to the limitation of the ability to meet protein needs in the body [15]. Weight gain in chickens can be achieved optimally if the supply of protein meets that required by the body, and hence satisfies the needs for muscle growth in the breast and wing [16]. The results showed that the requirement for protein for optimum breast weight and wing weight (Table 2).

As with protein, metabolic energy requirements as growth and production supports need to be considered. This is because the use of metabolic energy will affect the rate of feed consumption. The higher the energy content in the feed, the lower the consumption of the feed because the energy intake in chickens is heavily influenced by the energy contained in the feed. The accuracy in the calculation of the amount of metabolizable energy required is of great importance as excess energy may result in an increase in fat deposition [17]. Besides, metabolic energy is also correlated with proteins that can influence growth. In addition, the decrease in dietary energy and protein content leads to low protein digestion and decreased protein retention, thereby decreasing growth which ultimately increases the conversion value of the ration. As a result, the body growth will be affected and breast meat weight and wing weight will become low [12]. The percentage of breast weight would increase as body weight increases [18].

4 Conclusion

From the results of this study, it can be concluded the optimum requirement of dietary protein was 17.04% to produce a minimum breast weight of 151.96 grams. Also, the requirement of metabolizable energy was 2953.31 kcal/kg to produce 122.66 grams of breast weight. For wing weight, 17.43% of dietary proteins was required to achieve a minimum wing weight of 88.25 grams and 2970 kcal / kg to produce an 89.53 grams wing weight. The protein requirements and energy metabolism, each pile showed varying results. The existence of this diversity is influenced by genetic and environmental factors.

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