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The Effects of Different Sources of Protein on the Growth Performance and Digestibility Protein of Local Chickens Crossbreed: A Meta-analysis.

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ABSTRACT: A meta-analysis was conducted to determine the effects of different sources of energy on the growth performance and digestibility protein of local chickens crossbreed. A dataset was constructed based on relevant published papers. An algorithm was constructed from 2015 to 2023, with a search in Scopus, Web of Science, PubMed, and Medline using the MESH terms "chicken", "digestibility", "local chicken", "performance", and "nutrient digestibility". After careful evaluation, the final dataset consisted of 8 in-vivo studies comprising 31 treatment units. The data analysis and coding were performed using software R version 4.2.1 "Funny-looking kid" computing with library mode (cowplot); (tidyverse); and (viridis); and (nlme). Our meta-analysis with regard to growth performance, the different sources of protein did not affect the body weight, FCR, body weight gain (BWG), final body weight (FBW), and feed intake (FI) ($p > 0.05$). In conclusion, the different source of protein negatively affects parameters for growth performance and nutrient digestibility in local chicken crossbreeds.

Keywords: Crossbreed chickens; Digestibility; Growth performance; Meta-analysis; Nutrient digestibility

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INTRODUCTION

The livestock sector is one of the determinants of economic growth in Indonesia. At present the sectoral courtyards in Indonesia have developed, this can be seen from the maintenance management, genetics, and supporting equipment facilities that are currently being implemented.

This development is the result of a synergy between the government, related agencies, and breeders. Poultry is a commodity with the largest number in the livestock sector in Indonesia. Not only purebred chickens are experiencing development, but non-race or domestic chickens are also experiencing development. Data from the Directorate General of Livestock and Animal Health (2021) shows that the total free-range chicken population, including native chickens, in Indonesia is 317,054,290. The total population has increased from the previous year by 3.7%. This is also offset by high public demand for free-range chicken meat because it is considered healthier and has a chewier texture (Oszmalek et al., 2015).

Crossbreed chickens are chickens resulting from crossing male native chickens with female laying hens with the aim of improving genetics and increasing productivity and breeding (Samadi et al., 2021). The productivity of fighting cocks can be maximized if it is supported by maintenance management and quality feed. Crossbreed chickens are a new type of chicken in Indonesia, so that until now there is still no special crossbreed chicken feed that complies with the Standard National of Indonesia or SNI. Several components of feed ingredients that are often used as standard poultry feed are crude protein (CP), crude fibre (CF), metabolic energy (EM), fat, lysine, methionine, calcium, and phosphorus. The use of feed for livestock with nutritional content that is not according to standards will have an impact on livestock growth that is not optimal (Anggitasari, et al., 2016). A decrease in feed quality can occur due to several factors, namely the low quality of the ingredients used, damage during the feed production, and distribution process. The most important factor is the use of standard feed ingredients and adapted to the type of livestock being cultivated. The condition of the absence of special feed for crossbreed chickens with SNI makes breeders use broiler feed. Additionally, there is lack of information and inconsistency regarding the source of protein for local crossbreed chicken. Regarding this condition there is a method called "meta-analysis" to synthesise previously reported article. Thus, this study applies meta-analysis strategies that limit the effects of size and can synthesise results regarding the use of protein in chicken farming to provide a quantitative summary of the pooled findings. Accordingly, the aim of this study was to determine the effects of different sources of protein on the growth performance and digestibility of protein of local chickens crossbreed.

MATERIALS AND METHODS

Literature Search and Database Development

A raw database was constructed based on peer-reviewed and published research articles which reported used of different energy in the local crossbreed chicken. Articles were selected based on the Adli et al., (2023) method. An algorithm literature was constructed from 2015 to 2023, with a search in Scopus, Web of Science, Pub Med, and Medline using the MESH terms "chicken", "digestibility", "local chicken", "performance", and "nutrient digestibility". A single search from Google Scholar was also undertaken to identify additional studies that may have been relevant to our objectives. The time search was conducted between 01/01/2015 to 02/01/2023. Studies included in the meta-analyses can be seen in the table 1.

Data analysis

Prior to statistical meta-analysis, data analysis and coding were performed using R software version 4.2.1 (2022-06-23 UCRT)

– "Funny-Looking Kid" x86_64-W64-ming32/X64 computing with library mode (cow plot); (tidy verse); and (veridic); and (nlme) (Pinheiro et al. 2020; R Core Team. 2020). The modelling used by following (Sholikin et al., 2023).

$$Y_{ijk} = \mu + S_i + \tau_j + S\tau_{ij} + \beta_1 X_{ij} + b_i X_{ij} + \beta_2 X^2{}_{ij} + b_i X^2{}_{ij} + e_{ijk} \quad (1)$$

Where: Y_{ijk} = dependent variable, μ = overall mean value, S_i = random effect of the *i*th study, assumed to be $\sim N_{iid}\ (0,\ \sigma_S^2)$, τ_j = fixed effect of the *j*th of τ factor, $S\tau_{ij}$ = random interaction between the *i*th and *j*th level of τ factor, also assumed to be $\sim N_{iid}\ (0,\ \sigma_{S\tau}^2)$, β_1 = overall value of the linear regression coefficient of Y to X (a fixed effect), β_2 = overall coefficient value of the quadratic regression of Y to X (a fixed effect), X_{ij} dan $X^2{}_{ij}$= continuous values of the predictor variable (in linear and quadratic form, respectively), b_i = random effect of the study on the regression coefficient of Y to X, assumed to be $\sim N_{iid}\ (0,\ \sigma_b^2)$, and e_{ijk} = residual value from unpredictable error. $S\tau_{ij}$ dan S_i are taken to be independent variables that are chosen at random. A validation and significance test were conducted on the model. The significance of the values was determined using a one-way analysis of variance. It is significant if the P-value (**P** or **P-val**) < 0.05 and tend to be significant if the P-value between 0.05 and 0.1. As a result, $\mathbf{P}_l$ represents the P-value for the linear constant ($\boldsymbol{\beta_1}$) and $\mathbf{P}_q$ represents the P-value of quadratic constant ($\boldsymbol{\beta_2}$). Therefore, the validation test was conducted using the root mean square error (**RMSE**) and Nakagawa determination coefficient (**R2**) or $R_{GLMM}(c)^2$

$$RMSE = \sqrt{\frac{\sum(O-P)^2}{NDP}} \quad (2)$$

$$R_{GLMM}(c)^2 = \frac{(\sigma^2{}_f + \sum(\sigma^2{}_l))}{(\sigma^2{}_f + \sum(\sigma^2{}_l) + \sigma^2{}_e + \sigma^2{}_d)} \quad (3)$$

Note: O = actual value, P = estimated value, NDP = number of data point, $\sigma^2{}_f$ is the variant of a fixed factor, $\sum(\sigma^2{}_l)$ is the sum of all variants of the component, $\sigma^2{}_e$ is the variant due to the predictor dispersion and $\sigma^2{}_d$ is the specific distribution of the variant.

RESULTS AND DISCUSSION

Our meta-analysis presented of BW 255.44 g/bird with standard deviation (SD) 255.44 (table 2). Further, the result on the figure 1 was spread a far from the normal line. In line, both BWG and FI were maximum at 862 g/bird and 515.00 g/bird, respectively (table 2). Thus, figure 2 and 4 were spread a far from the normal line. The current meta-analysis showed the crude protein digestibility (CPD) was 83.10% with SD 34.22% (table 2). Our meta-analysis with regard to growth performance, the different source of protein did not affect the body weight, FCR, body weight gain (BWG), final body weight (FBW), and feed intake (FI) (p > 0.05) both in quadratic and linear models. In light of this, the nutrient digestibility was not affected by the different source of protein on local crossbreed chickens (p > 0.05) (table 3).

Table 1. Studies included in the meta-analyses of the effects of different source of protein on the growth performance and digestibility protein of local chickens crossbreed

No	References	Source of protein	Form	Periods (d)	Level given (%)	Strain of Local crossbreed chicken
1	Utomo et al. (2019)	Fermented sweet potato	Powder	1-13	0-16	Local crossbreed chicken
2	Raras et al. (2017)	Fermented *Azolla microphylla*	Powder	1-70	0-20	Local crossbreed chicken
3	Fuddin et al. (2022)	Black Soldier Flies	Powder	35-63	2-10	Local crossbreed chicken
4	Melita et al. (2018)	Fermented *Azolla microphylla*	Powder	28-63	0-10	Local crossbreed chicken
5	Sutomo et al. (2021)	Fermented Rice Bran	Powder	20-30	28-56	Local crossbreed chicken
6	Trisiwi et al. (2020)	Crust of Bread	Powder	0-40	1-56	Local crossbreed chicken
7	Ajibah et al. (2020)	Fermented Tapioca Waste	Powder	25-75	28-56	Local crossbreed chicken
8	Angelina et al. (2021)	Fermented Kiambang	Powder	0-10	1-56	Local crossbreed chicken

Table 2. Descriptive statistics of the effect different source of protein on the growth performance and digestibility protein of local chickens crossbreed

No	Parameters	N	Mean	SD	Min	Max
1	BW	30	234.55	123.22	0.00	255.44
2	BWG	30	232.22	188.62	0.00	862.00
3	FBW	30	432.74	234.54	0.00	943.00
4	FCR	30	1.98	1.98	0.00	5.54
5	FI	30	81.22	82.11	0.00	515.00
6	CPD	30	34.95	34.22	0.00	83.10

BW – body weight, FBW– final body weight, BWG – body weight gain, FCR – feed conversion ratio, M – model; N – number of data; SE – standard error; PD- protein digestibility, RMSE – root mean square errors; AIC – akaike information criterion; L – linear

Table 3. Regression linear model of effect of different source of protein on the growth performance and digestibility protein of local chickens crossbreed

No	Responses	Unit	Model	N	Intercept	SE intercept	Slope	SE Slope	*p*-value	RMSE	AIC
1	BW	g/bird	L	30	234.55	12.33	0.34	0.88	0.81	1.33	0.12
2	BWG	g/bird	L	30	232.22	45.66	2.33	1.22	0..33	1.22	0.13
3	FBW	g/bird	L	30	432.74	56.75	1.34	2.33	0.75	0.34	0.34
4	FCR	-	L	30	1.98	0.76	1.22	1.00	0.34	0.33	0.23
5	FI	g/day/bird	L	30	81.22	12.34	1.32	0.56	0.23	0.21	0.33
6	CPD	%	L	30	34.95	23.44	0.45	1.12	0.45	1.08	0,45

BW – body weight, FBW– final body weight, BWG – body weight gain, CPD – Crude protein digestibility, FCR – feed conversion ratio, M – model; N – number of data; SE – standard error; RMSE – root mean square errors; AIC – akaike information criterion; L – linear.

The differences of the source protein might have influenced the result of the growth performance. The different sources of the protein given were depending on the period rearing of the chicken, total level given, specific strain of the local crossbreed chicken, the type of the protein given both powder or liquid, and management. According to Anggitasari, et al. (2016) that high protein in feed will increase body weight, while low protein content will inhibit growth due to a deficiency of amino acids in the body. Excessive protein content in the livestock body will be disposed of as ammonia. The process of protein metabolism can run well due to the performance of internal organs such as the liver, kidneys, heart and spleen (Oszmalek et al., 2015). A high increase in chicken body weight if followed by an increase in internal organ weight which also increases will reduce the percentage of carcasses. Breeding of crossbreed chickens aims to produce a high yield weight and a high percentage of meat, thus increasing the farmer's profit (Pauletto et al., 2020).

Phenotypic traits in chicken can be influenced by two factors, namely genetic factors and environmental factors. Production performance in chickens such as body weight gain, feed conversion, feed consumption and mortality can be seen by recording phenotypic traits (Petracci et al., 2015). Gene changes in livestock cannot be done directly, but gene expression in livestock can be influenced by environmental influences, for example feed. Nutrigenomics is the science of animal nutrition in molecular biology that studies the effects of feed nutrition on gene expression so that it influences animal phenotypes (Singh et al., 2015). Specific genes might have influenced the result of the growth performances including body weight, FCR, BWG, FBW, and FI (Prakash et al., 2021).

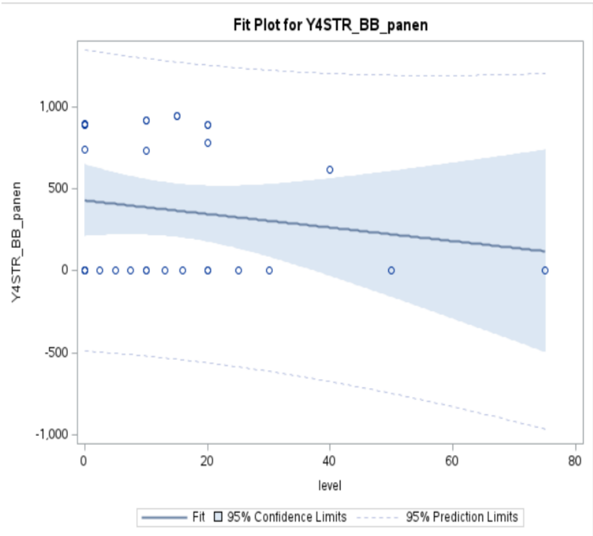

Figure 1. The effects of different source of protein on the body weight of local chickens crossbreed

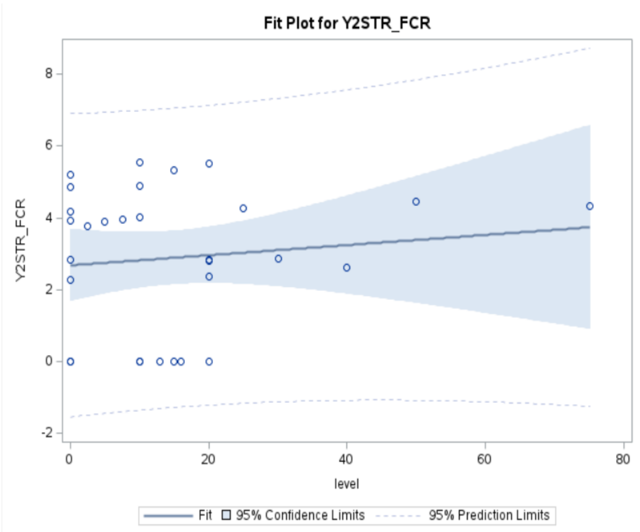

Figure 2. The effects of different source of protein on the FCR of local chickens crossbreed

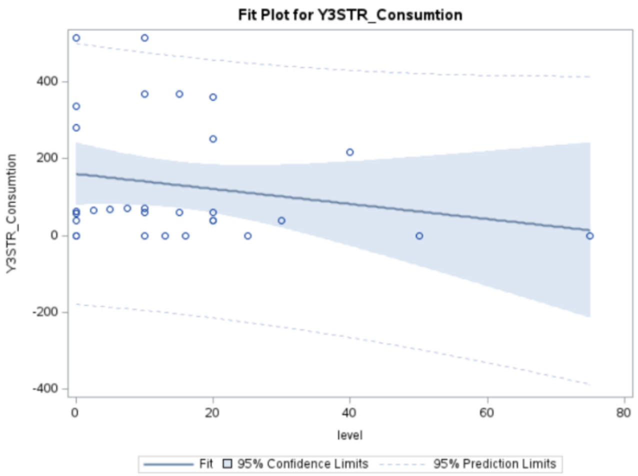

Figure 3. The effects of different source of protein on the feed intake of local chickens crossbreed

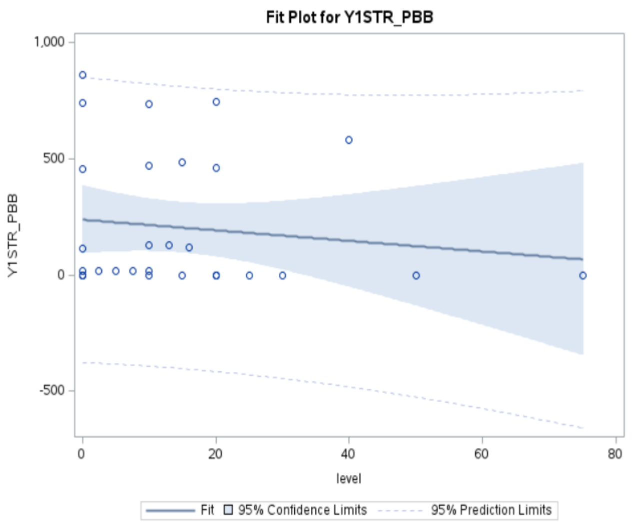

Figure 4. The effects of different source of protein on the body weight of local chickens crossbreed

Furthermore, the starter period is a critical phase for chickens because it includes the formation and growth of cells and tissues in the organs of the body, one of which is the digestive organs. Optimal chicken body weight gain can be achieved if the digestive organs grow and develop perfectly, especially during the starter phase. Weekly body weight gain data is presented with livestock age data. However, these periods are related nutrient digestibility. Inappropriate feed protein composition will have negative impacts such as growth that is not optimal and produces low quality chicken carcasses (Singarimbun et al, 2013). Scheuermann et al (2004) added that the accelerated increase in body weight and chest muscle weight is related to the amount of myofiber in the chicken muscle. Chickens in the finisher period consume feed that is not used for organ growth and skeletal development, but is used to fulfill basic life needs and produce.

The purpose of raising crossbreed chickens is high productivity in the growth phase so that the meat produced is high. The use of feed with a protein content of 20% produces the best body weight or produces a maximum growth pattern, this if applied to a farm will have an impact on increasing the economic value of the breeder (Svihus, 2014).

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CONCLUSION

In conclusion, the different source of protein negatively affects parameters for growth performance and nutrient digestibility in local chicken crossbreeds.

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