Duck Farming in Coastal Area: Assessing Nutritional Status and Its Contribution to Egg Production

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ABSTRACT

The nutritional status of laying ducks is the balance between the supply of nutrients from the feedstuff consumed with the nutritional needs for maintenance and egg production. Therefore, the nutritional status can be measured through the level of egg production. This study was aimed to evaluate the nutritional status of laying ducks cultivated in coastal areas and its contribution to egg production. Using a survey method with a Dietary Assessment Approach onto 200 flocks of ducks and their breeders as a sample. Every week for 6 consecutive weeks, the farmers were interviewed about the amount and type of feed stuff that was given to their ducks. Sampling from each feedstuff was carried out to be analyzed in the laboratory for its nutritional content. The results of the analysis were used to calculate the amount and nutritional components consumed by the ducks, then compared with the nutritional requirements of laying ducks according to the Indonesian National Standard (INS). Nutritional status is considered Sufficient Status (SS) if the consumption of ducks from each nutritional component is the same as INS, and Insufficient Status (IS) if $< INS$. Daily egg production was recorded. To determine the contribution of nutritional status to egg production, the data were analyzed by regression. The results showed that 58.50% of samples were in SS and 41.50% IS. The regression results showed that the contribution of SS to egg production was 72.132% higher than the contribution of IS which was 49.91%. The IS ration contains high rice brand while the portion of anchovies and abandoned fish is relatively low. The study concluded that the level of egg production was determined by nutritional status, increasing the nutritional status from IS to SS can be done by reducing the portion of bran and increasing the portion of anchovies and fish waste in ration.

Keywords: Duck, egg production, nutritional status.

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I. INTRODUCTION

About 1.15 billion ducks (*Anas spp.*) kept in 2019 worldwide, 1.0 billion (88%) were in Asia, where the largest duck populations were in China, Vietnam, Bangladesh, and Indonesia [1]. Meanwhile, duck farming in Indonesia plays an important role as producer both of egg and meat as well as it acts as a home industry to many households in rural area. The average of national egg and meat consumption in the last four years (2015-2020) growth 2.17% [2]. In addition, the current population of duck is 49.709.403, with 37.12% (18.45 million) of the population are bred in coastal area by approximately 2.65 million rural households [3]. Furthermore, as a maritime country with 99.093 km coastline [4]. Indonesia's coastal ecosystem provides abundant source of energy and protein for ducks such as phytoplankton, crabs, shrimp, fish, and abandoned fish which are accessible and cheap. These potentials support the development of duck farming in coastal area.

Nutritional status in this study is defined as the balance of supply and requirement of nutrition for poultry or the

population of duck farming for maintenance and production [5]. It is also can be determined by the genetic factor despite its capacity is optimum only under a balanced nutrition intake. In a more practical context, estimating the nutritional status is related to the production and environmental factors of duck farming [6]. As this issue has a significant impact on productivity of duck farming in rural and coastal area under the traditional management [7].

Information about nutritional status of ducks in traditional farming systems in coastal areas is very important to build awareness of farmers, so that they pay attention to feed ingredients that are in accordance with the nutritional needs of their ducks. However, such information is still scarce. This study found at least five sources of research on duck farming in coastal areas from 2012-2020, but none of them discuss nutritional status. [8] evaluated the growth of three duck genotypes in coastal areas, [9] examined the duck production strategy and the profile of duck breeders in coastal areas, [10] analyzed the economics of duck farming in coastal areas, [11] defines ducks as an effort to utilize coastal resources, and [12] examines the prospects of pekin duck rearing in the coastal region.

Therefore, this study aim was evaluating the nutritional status of duck farms in coastal areas and their contribution to egg production. The results of this study are expected to (i) provide additional information and understanding to farmers, so that they can take advantage of the potential of feed ingredients available in coastal areas for the advancement of their livestock, (ii) fill in the existing literature gaps, especially those related to the nutritional status of duck farms in coastal areas.

II. MATERIALS AND METHODS

A. Study Area and Sample Criteria

This study was conducted between April and August 2020 in South Sulawesi province. The location selection was laying down to the fact that the province is the top two of duck population in Indonesia below West Java province, and also is the biggest duck population for coastal area in Indonesia [3] Sampling process was conducted in three steps. First step was determining the location of the sample (district) with the largest population of ducks in the coastal area, namely Takalar district. Following this step was determining two subdistricts as the area sampling. Final step was determining 200 sample breeders for the observation unit from the two subdistricts based on four criteria as follows:

- the type of duck which has been raised is a local duck bred from Alabio duck (*Anas platyrhynchos* Borneo) and the Javan duck (*Anas platyrhynchos javanica*) crossing,
- have been raising layer ducks for 2 years or more as breeding experience thus it could precisely answer the researcher's questions,
- the minimum population of duck is 50 dengan pemeliharaan intensif,
- the age of ducks is 7-11 months in fact that such that age the ducks are still in production phase I [13] so the samples were relatively homogeneous.

B. Method and Data Collection

Research on nutritional status can be done through deterministic and a survey approach. The deterministic approach is carried out by providing certain nutrients with different levels into the ration which is called treatment, then its effect on the production or performance of ducks is measured [5], While the survey approach is carried out by measuring one or several nutritional components through feedstuff consumed daily and then the performance of ducks is measured [6], [5], and [14]. This study used survey method to evaluate the nutritional status of duck farming in coastal areas that are traditionally kept by farming households in rural areas. All data were collected through observation, notes, and in-depth interviews with farmers.

TABLE I: NUTRIENT CONTENT OF FEEDSTUFF CONSUMED BY THE DUCKS IN THE LOCATION OF THE STUDY

Feedstuff	Nutrient content					
	ME (Kcal kg ⁻¹)	CP (%)	CF (%)	CFb (%)	Ca (%)	P (%)
Ricebran	1617	10.04	6.21	11.10	0.08	0.21
Corn	3320	9.03	4.12	3.55	1.31	0.41
Tubers	1236	5.12	1.55	6.13	0.11	0.14
Anchovy	3310	44.98	7.25	1.65	7.25	4.85
Abandoned Fish*	3451	35.72	11.35	3.11	7.67	3.07

* Abandoned fish = Inconsumable fish; ME = metabolic energy; CP = Crude protein; CF = Crude fat; CFb = Crude fibre; Ca = calcium; P = phosphor (Source: Analysis result of the Laboratory of the fundamental animal science, Faculty of Science and Technology, Alauddin State Islamic University Makassar, Indonesia, 2020).

C. Variables and Data Analysis

The variables measured were the amount and type of feedstuff consumed, nutrient consumption, and the percentage of daily egg production. To determine nutrient consumption, all types of feed ingredients consumed samples were analyzed first by the proximat method. Then the results of the analysis were used to calculate nutrient consumption based on the amount and type of feed consumed. Nutrient consumption is calculated by equation (1) below:

$$\text{Nutrient consumed} = \sum i(Ni) / \sum d \quad (1)$$

$\sum i$ ($i = 1 \dots n$) is total consumption on each feed stuff (g duck⁻¹); Ni ($i = 1 \dots n$) is ingredient of ; EM, CP, CF, CFb, Ca, and P in ration, and $\sum d$ is total of fed duck. For instance, if a duck consumed 100 g ricebran, thus this duck has gained 10.4 g crude protein. This value obtained from ricebran consumption $100 \text{ g} \times 10.04\%$ (protein in ricebran) = 10.4 g (see Table I). Based on Table I, besides 10.4 g or 10.4% crude protein, the duck also gains $100 \text{ g} \times 6.21\%$ crude fat, $100 \text{ g} \times 11.10\%$ crude fiber, $100 \text{ g} \times 0.08\%$ Ca, and $100 \text{ g} \times 0.21\%$ phosphor. This calculation is applied on corn, tubers, anchovy, and abandoned fish. If the number of ducks is more than 1 (flock), the nutritional consumption is divided with the number of ducks in the flock.

Table I presents the types and nutritional content of feed ingredients used by farmers in the study area, as follows; ricebrand, corn, tubers, anchovy, and abandoned fish. These four feedstuffs are available enough and are generally used by all breeders. The value and composition of the nutritional content presented in Table I is the result of a proximate analysis in the animal feed laboratory. Furthermore, to determine nutritional status, the results of the calculation of nutrient consumption in equation (1) were compared with the nutritional standards set by [15], in Table II.

Table II shows that the nutritional status is stated to be sufficient (Sufficient Status = SS), if the consumption of nutritional components in the form of (EM, CP, CF, CFb, Ca and P) was in the range of SS numbers. On the other hand, nutritional status is considered insufficient (Insufficient status = IS) if consumption was less than the SS range. Especially for crude fiber, it is considered IS if it is greater than 11%.

TABLE II: NUTRITIONAL STATUS BASED ON THE SUFFICIENT STATUS (SS) OR NUTRITIONAL REQUIREMENT OF LAYER DUCKS

Nutrient	Nutritional status	
	Sufficient Status (SS)*	Insufficient Status (IS)
Metabolic energy (ME)	2650-3100 Kcal kg ⁻¹	< 2650 Kcal kg ⁻¹
Crude Protein (CP)	15-18%	< 15%
Crude Fat (CF)	3-6%	< 6%
Crude Fibre (CFb),	6-11%	> 11%
Calcium (Ca),	3-5%	< 3%
Phosphor (P)	0.6-1.0%	< 0.6%

Source: INS (2017).

D. Nutritional Status Contribution toward Egg Production

Daily egg production was calculated using equation (2) as follows:

$$\text{Daily Egg Production} = \frac{\text{Total daily egg collection}}{\text{Total hen}} \times 100 \quad (2)$$

The contribution of nutritional status to egg production was estimated using multiple linear regression where the nutritional component is the independent variable, egg production is the dependent variable, and nutritional status is the Dummy variable (D) [16] and [17] where D=1 for SS and D= 0 for IS. The regression model in equation (3) as follows:

$$\text{LN}EP = \text{LN} \beta_0 + \beta_1 \text{LND} + \beta_2 \text{LNME} + \beta_3 \text{LNCP} + \beta_4 \text{LNCF} + \beta_5 \text{LNCFb} + \beta_6 \text{LNCa} + \beta_7 \text{LN}P + \epsilon_i \quad (3)$$

where LN – Natural logarithm; EP – Egg Production; β_0 – intercept; β_i ($i = 1 \dots 13$) – coefficient; D – dummy variable; D = 1 for Sufficient Status (SS), and D = 0 for the Insufficient Status (IS); ME – Metabolic Energy; CP – Crude Protein; CF – Crude Fat; CFb – Crude Fibre; Ca – Calcium; and P – Phosphor; ϵ_i : error.

III. RESULT AND DISCUSSION

A. Assessing Nutritional Status

Table III presents the average nutrient consumption of each component. In this table, a flock of ducks with SS status has been separated from ducks with IS status. From 200 samples observed, there were 117 (58.50%) samples with SS status, and 83 (41.50%) with IS status. It was reported by [18], [19] that there are many factors that affect egg production, one of which is the nutritional content of the ration because the current research results show that daily egg production in SS is 73.14%, while in IS 51, 36% showed that flocks of ducks with SS status gave higher egg production than IS. This result is in accordance with the statement of [5] that balanced nutritional status between consumption and production needs (SS) will provide optimal production, while unbalanced (IS) will provide low production.

TABLE III: NUTRITIONAL STATUS AND EGG PRODUCTION

Nutritional components, egg production, sample	Sufficient Status (SS)		Insufficient Status (IS)	
	Mean	SS*	Mean	IS*
Metabolic energy (ME, Kcal kg ⁻¹)	2650.73	2650-3100	1943.81	< 2650
Crude protein (CP, %)	19.35	15-18	12.96	< 15
Crude fat (CF,%)	7.00	3-8	6.26	> 8
Crude fibre (CFb,%)	6.08	6-11	9.26	> 8
Calcium (Ca,%)	3.05	3-4	1.04	< 3
Phosphor (P,%)	1.40	0.6-1.0	0.61	< 0.6
Egg Production (%)	73.14	-	51.36	-
Sample	117	-	83	-

Source: *INS, (2006).

1. Energy-protein

Previous study conducted by [20] reported that duck rations containing ME 2707 Kcal kg⁻¹, and 16.16% CP, lead to daily egg production by 74.48%. Reported by [21], ME 2800 kcal. kg⁻¹ and CP 18% as sufficient nutritional status to

maintain daily egg production of alabio ducks above 70%. The use of ME and CP from these researchers [20] and [21] is in accordance with [15] and is in line with the current research results. Researchers [22] and [23] confirmed that in formulating the ration for laying ducks, ME and CP are the first nutritional needs that must be considered because they have a significant effect on egg production.

2. Crude fat (CF)

It was reported by [20] that the use of crude fat (CF) was 4.12-4.51% in the ration of alabio ducks, reaching an egg production of 75.34-76.99%. This is in line with the results of the current study which obtained a daily egg production of 74.13% with a CF content of 7%, and in accordance with [15] which recommends the use of CF in rations between 3-8%.

1. Crude fiber (CFb)

Using CFb by 6.39-9.00% in the ration lead to 75.34-76.99% egg production [20] and [24]. While [25] reported that diet containing 6.77% CFb significantly lead to duck egg production above 70% compared to 4.77% CFb. Although ducks have limitations in digesting CFb, fed them on certain levels did not interfere egg production [26] and [27]. The results of the current study obtained an average daily egg production by 74.13% with CFb content 6.06%. Those results of this study are in line with the CFb content recommended by [15].

2. Ca-P

For mineral needs of Ca and P, [28] reported that the content of Ca (3.75%) and P (0.45%) provided daily egg production by 75-84%. Another researcher [29] reported that duck rations containing 4.35% Ca resulted in 75% daily egg production. While [30] reported 3.6% portion Ca in duck rations with daily production 74.52%. These researchers are in line with the current study, which has used Ca and P in accordance with [15] recommendations and obtained average daily egg production by 74%.

B. Assessing Contribution with Regression Analysis

To determine the contribution of nutritional status to egg production, multiple linear regression was used [17]. In this regression, as the dependent variable was egg production, nutritional components (ME, CP, CF, CFb, Ca, and P) were independent variables, and nutritional status was dummy variable. Dummy D=1 for SS status and dummy D=0 for IS status.

In regression analysis, it is necessary to test the classical assumptions in order to obtain the BLUE (Best Linear Unbias Estimator) regression model. There are 5 classical assumption tests that are often used, as follows: normality, heteroscedasticity, multicollinearity, linearity, and autocorrelation. According to [16] and [17] the linearity test is no longer needed if the regression model has been transformed into linear form with natural logarithms (Ln) such as equation (3). Furthermore, the autocorrelation test is only needed on times-series data because this data is influenced by the previous year's data. Based on empirical experience [17], a large amount of data more than 100 observations ($n > 100$) can be assumed to be normally distributed.

Because this estimation model has been transformed into Ln form, using cross-sectional data (not time-series), and the

data is 200 ($n > 100$), then linearity, autocorrelation, and normality tests are no longer needed, except for heteroscedasticity and multicollinearity tests. The heteroscedasticity test aims to test whether in the regression model there is an inequality of variance from one observation residual to another observer. If the variance of the residuals from one observer to another is the same, then it is called homoscedasticity and if it is different, it is called heteroscedasticity. A good regression model is a homoscedasticity regression model or there is no heteroscedasticity. One way to detect the presence or absence of heteroscedasticity is performing the Glejser test [31]. The Glejser test is regressing the absolute value of the residual on the independent variable, with significant criteria if the value of sig. > 0.05 . The Glejser test which was carried out with the help of SPSS 20 obtained sig. > 0.05 , which means that the regression model used is free from heteroscedasticity.

Furthermore, the multicollinearity test aims to determine whether in the regression model there is a correlation between independent variables or not. A good regression model should not have a correlation between the independent variables [31]. This test uses the Variance Inflation Factor (VIF) value, with the criteria that if the VIF is less than 10, it means that there is no correlation between the independent variables. The results of the multicollinearity test using SPSS 20 obtained a VIF value of 7.12 which means that there is no multicollinearity. Thus, the regression model used in this study (Table IV) has fulfilled the requirements as a BLUE (Best Linear Unbias Estimator) model, so it has accuracy in estimating the contribution of nutritional status to egg production.

TABLE IV: RESULT OF MULTIPLE LINEAR REGRESSION ANALYSIS

Variable	Coefficient	Std. Error	T-statistic	sig.
Intercept (β_0)	49.317	4.386	11.244	0.027*
Energy (ME)	0.016	0.005	2.917	0.039*
Crude Protein (CP)	0.149	0.047	3.201	0.000*
Crude Fat (CF)	0.073	0.015	5.014	0.046*
Crude Fibre (CFb)	0.002	0.001	2.117	0.031*
Calcium (Ca)	0.188	0.020	9.432	0.000*
Phosphor (P)	0.116	0.019	6.216	0.012*
Dummy SS (D=1)	22.221	3.048	7.291	0.010*

R-Multiple (0.742); R^2 (0.551); F-Statistic (217.60); * significant ($p < 0.05$).
Source: Author-made report based on the result of regression analysis using SPSS 20.

Table IV shows R-Multiple 0.742 which means that there was a strong correlation between all nutritional components and egg production. R^2 0.551 means that 55.10% of egg production was determined by the independent variables in the model, while the remaining 45.90% was determined by other variables outside the model. F-Statistic 217.60 ($p < 0.05$) showed that simultaneously, there was a significant effect between the independent variables on egg production. T-test (column 4) with sig value (column 5) showed that all independent variables partially (individual) had a significant effect ($p < 0.05$) on egg production.

According to [32] the regression coefficient value in Table IV can be explained as follows. The intercept value of 49.317 means that the current use of nutritional components (ME, CP, CF, CFb, Ca, P) results in 49.317% egg production. The ME coefficient of 0.016 means that every 1% increase in ME

in the ration will contribute 0.16% of egg production. CP=0.149 means that every 1% increase in CP will contribute 1.49% to egg production. CF=0.073; every 1% increase in CF will contribute to 0.73%. Meanwhile 0.002 CFb mean that every 1% increase in CFb will contribute 0.02% egg production. The coefficient value of 0.02 from this CFb indicates that CFb is already at the turning point, meaning that the addition or increase of CFb will have a negative impact on egg production. This is in line with the opinion [27] and [33] that CFb is an anti-nutritional substance which if the portion is added it can reduce digestibility and egg production. Furthermore, Ca=0.188 means that every 1% increase in Ca will contribute to an increase in egg production of 1.88%. P value=0.116; that every 1% increase in P contributes 1.16% egg production.

Based on regression coefficient from Table IV, can be derived the regression equation for SS status (D=1) and IS status (D=0) as follows:

For SS (D=1):

$$EP = 49.317 + 22.221 D + 0.016 ME + 0.149 CP + 0.073 CFat + 0.002 CF + 0.188 Ca + 0.166 P$$

$$EP = 49.317 + 22.221 (1) + 0.016 ME + 0.149 CP + 0.073 CFat + 0.002 CF + 0.188 Ca + 0.166 P$$

$$EP = (49.317 + 22.221) + 0.016 ME + 0.149 CP + 0.073 CFat + 0.002 CF + 0.188 Ca + 0.166 P$$

$$EP = 71.538 + 0.016 ME + 0.149 CP + 0.073 CFat + 0.002 CF + 0.188 Ca + 0.166 P$$

For IS (D=0):

$$EP = 49.317 + 22.221 D + 0.016 ME + 0.149 CP + 0.073 CFat + 0.002 CF + 0.188 Ca + 0.166 P$$

$$EP = 49.317 + 22.221 (0) + 0.016 ME + 0.149 CP + 0.073 CFat + 0.002 CF + 0.188 Ca + 0.166 P$$

$$EP = 49.317 + 0.016 ME + 0.149 CP + 0.073 CFat + 0.002 CF + 0.188 Ca + 0.166 P$$

TABLE V: INTERCEPT AND SLOPE OF SS AND IS NUTRITIONAL STATUS

Variable	Intercept and slope of nutritional status	
	SS (D = 1)	IS (D = 0)
Intercept	71.538	49.317
Metaboloc Energy (ME)	0.016	0.016
Crude Protein (CP)	0.149	0.149
Crude Fat (CF)	0.073	0.073
Crude Fibre (CFb)	0.002	0.002
Calcium (CA)	0.188	0.188
Phosphor (P)	0.166	0.166
Dummy SS (D=1)	22.221	-
Dummy IS (D=0)	-	0
Total Contribution	72.132	49.911

Source: Written by the author based on Equation (4) and (5).

Table V presents intercept and slope of the SS (D=1) and IS (D=0) equations. The intercept is defined as the value of egg production which was obtained by deploying of recent nutritional components. The SS intercept value (D=1) was 71,538 while the IS(D=0) intercept was 49,317. Slope is defined as the value that each nutritional component contributes to egg production.

All nutritional components in the SS (D=1) and IS (D=0) equations have the same value, the only difference is the intercept. The SS equation (D=1) has an intercept of 71,538 which is obtained from $(49,317 + 22,221 D)$, because $D=1$ then $49,317 + 22,221(1) = 71,538$. The intercept in the IS equation (D=0) is 49.317, it is obtained from

$49.317 + 22.221(0) = 49.317$. This difference makes the SS regression line ($D=1$) above the IS regression line ($D=0$) with a slightly larger slope as shown in Fig. 1.

Fig 1. The difference intercept and slope between SS and IS status.
(Source: Table V).

TABLE VI: FEED STUFF COMPOSITION ON SS AND IS RATIOMS

Feedstuff	SS		IS	
	Mean	Std Deviasi	Mean	Std Deviasi
Ricebran (%)	45.66	15.44	63.11	20.46
Corn (%)	17.21	5.71	13.25	6.13
Tubers (%)	12.46	5.69	10.21	5.25
Anchovy (%)	11.24	3.11	5.77	6.77
Abandoned fish (%)	13.43	5.33	7.66	9.18
Total	100.00	-	100.00	-

Fig. 1 shows a phenomenon that correlate with feed and ration compositions as it is shown on the Table VI. In Table VI it appears that the bran content in the IS ration is too high at 63.11% much higher than 40% for the maximum limit of bran in the duck ration as it was recommended [33]. Previous studies reported that the portion of bran in duck rations by 40-60% reduced egg production and quality [27]. Rice bran not only contains high crude fiber (13%) but also contains phytic acid as an anti-nutritional compound that interferes the activity of protease [26] and [34]. Furthermore, the portion of anchovy and abandoned fish in the IS ration was very low compared to the SS ration, despite these two types of feedstuffs contain high CP, Ca, and P. Changes in nutritional status from IS to SS in the next study can be done by reducing the portion of rice bran while increasing the portion of anchovy and abandoned fish in the ration.

IV. CONCLUSION

The study concluded that 200 of duck samples which observed their nutritional status have 117 (58.50%) SS (Sufficient Status) and 83 (41.50%) IS (Insufficient Status). The existence of IS nutritional status due to high portion of bran in ration, meanwhile anchovy and abandoned fish portion rather low. SS contributed to 72.132% egg production and IS for 49.911% egg production, proved that a flock of laying duck which is receiving SS nutrition, in accordance

with the Indonesian National Standard (INS) provided higher egg production. Enhancement of nutritional status from IS become SS is possible by lowering bran portion and enhancing portion of anchovy and abandoned fish. This change led to egg production improvement from 49,911% to 72,132%.

V. RECOMMENDATION

It is recommended that breeders in the research location get special counseling that focuses on improving the nutritional status of ducks through the use of feed ingredients from coastal resources. Such counseling can improve knowledge and skills of farmers, particularly in selecting and combining feed ingredients in improving the nutritional status of their ducks.

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AUTHOR'S DECLARATION

1. There is no conflict of interest from the beginning of the study up to publishing this manuscript.
2. This study was carried out without financial support from the government or other parties.
3. This manuscript has never been published before and is not under consideration for publication in any other journal.

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