Biological response to quails (*Coturnix coturnix*) given hydrolyzed feather meal at different levels

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Abstract. The biological response is one of the important parameters to evaluate the performance of a farm. Each individual will give a different biological response according to the treatment applied. Feeding is one of the biological needs of the quail (*Coturnix coturnix*). The purpose of this study was to evaluate the biological response of quails to the treatment of hydrolyzed feather meal with different levels. A total of 100 heads quail, one week old were used as samples. The treatment consisted of four levels (L\textsubscript{0} = 0\%, L\textsubscript{1} = 1\%, L\textsubscript{2} = 1.5\% and L\textsubscript{3} = 2\%). Each treatment was repeated five times. The treatment was used a unidirectional design of completely randomized design (CRD) a 4x5 = 20 treatment units. Each treatment unit was used five heads quails. The duration of the observation process was 30 days. The data were analyzed statistically using ANOVA. The results showed that the treatment of hydrolyzed feather meal at different levels at a level of 2\% did not had a significant effect (P>0.05) on all parameters. The biological response of the increase in body weight gain was in the range of 2.00-2.37 g/head/day. The highest body weight in the treatment with L\textsubscript{3} (2\%), in weeks 3 and 4. The average intake of feed was 14.84-15.79 g/head/day, the feed conversion was 0.60-0.68 and the in vivo digestibility of the protein was 40.48-51.69\%. The results of the study indicate that the introduction of broiler feather meal from the hydrolysis in the quail feed (*Coturnix coturnix*) at a level of 2\% has the same biological response. Therefore, an introduction with a level of >2\% should be applied to discover the differences between treatments.

1. Introduction
The feathers are one of the by-products of cattle that have a high protein content. The feathers obtained from the slaughtering activities of poultry. In addition, to other types of secondary feathers that are often processed, there are parts of the head, legs and viscera [1]. The poultry industry is one of the largest livestock business sectors. This sector has evolved rapidly in the last 100 years, from domestic production to commercial production with modern equipment [2]. This effort has provided a source of new protein sources for humans [3]. The protein levels in the feathers are dominated by keratin-like proteins. The protein levels in the feathers are not very different from the protein levels in fishmeal [4, 5]. The skin also has a waxy coating that makes its solubility very low.

The potential production of waste feather from poultry slaughtering activities in Indonesia is quite significant. The component of the feather in poultry can reach 3\% of body weight [6]. Based on statistical data for 2015, the province of South Sulawesi produced poultry meat (carcass) for poultry;
native chicken (25,838 tons) + layer (7,679 tons) + broiler (50,829 tons) = 84,346 tons or 84,346,000 kg of carcass weight. If it is assumed that the carcass weight reaches 60% of the live body weight, then the total live weight of the poultry = 84,346,000 kg/ 60% = 140,576,667 kg. If it is assumed that the feather component in poultry is 3% of the live body weight, so the amount of waste from feather production reaches, 3% x 140,576,667 kg = 4,217,300 kg or ≈ 4,217.3 tons.

Poultry feathers have the potential as a raw material for feeding poultry, such as chicken, duck or quail. The problem is that the feathers have a very low digestibility. The low level of digestibility was caused by the presence of disulfide bonds (S-S) that form the structure of the feathers. To increase feather digestibility it can be done through hydrolysis technology. The hydrolysis technology can be carried out by physical, chemical and enzymatic processes, and the enzymatic process can be carried out using microbes (bacteria). The hydrolysis process with Bacillus subtilis FNCC 59 produced an in vitro protein digestibility level of 62.73%[7]; while the hydrolysis process using a chemical process is only 21.76%[8].

The quail is a type of bird that is currently developing in Indonesia. The quail is a type of bird that has the shape of a bird. The quail populations in some countries have experienced almost double development [9]. The quail is widely used as experimental animals because it has a short life cycle and is more resistant to diseases [10 - 12]. The quail experiences genital maturity at 6 weeks and easily adapts to maintenance conditions [13]. However, the need to feed on quail is one of the problems, especially the compliance of food sources of proteins and amino acids [14 -15].

The application of feathers meal as a source of feed material for protein sources, especially in quail birds, has not been widely reported. This research is very important as a source of scientific information related to the potential of feather waste as an alternative source of protein ingredients. The objective of this study was to evaluate the biological response of quail to the treatment of feather meal produced from hydrolysis at different levels.

2. Materials and Methods

2.1. Materials

This study was uses local quail (Coturnix coturnix) (unisexed), one week old as a research object. A total of 100 heads quail, weighing 30-36 g were used as samples. The feed ingredients was needed to make the feed concentrate are hydrolyzed feather, corn, bran, coconut meal, fish meal, soybean meal and mineral mixture. The feather meal hydrolyzed was produced from broiler feather waste. The feather waste was obtained from the poultry slaughterhouse, Daya, Makassar City. The feather waste of the broiler were hydrolyzed using a concentration of 1 M-HCl 20% (v/v) + autoclave (21 Psi). The cage was used 20 from bamboo constructions with a size of 30 cm x 20 cm x 30 cm.

2.2. Methods

2.2.1. Research design

The experiment was carried out experimentally using a completely randomized design (CRD) a 4x5 directional patterns. The study was used four treatments with five repetitions. Based on this pattern, 20 treatment units were obtained. Each treatment unit requires a cage unit that contains 5 quails.

The treatment was applied to 4 levels of feather meal in the concentrate, namely: (L₀ = 0%, L₁ = 1%, L₂ = 1.5% and L₃ = 2%). The duration of the observation process was 30 days. The composition dan formulations of the feed ingredients that used in the study was presented in Table 1.

2.2.2. Implementation of research

The research was carried out in 3 stages, (1) preparation, (2) implementation and (3) data processing. The preparation stage includes the stage of preparation of feed ingredients, cages, and placement of quail in the cage. Preparation of feed ingredients includes the process of taking broiler feather waste and production process of feather meal. The preparation of cages includes cleaning, installing curtains, lamps, feed and drinking places and disinfection processes as well.
The implementation stage consists of placing the quails in the cage. A total of 5 quails were placed in each cage. Quail was given with sugar and vitamins to improve the initial condition. The initial weighing process was carried out on the first day. The quail weighing activities were carried out every week. Feeding was controlled every day, while drinking was carried out in an *ad libitum*.

### 2.2.3. Data analysis

The data results of this research were analyzed statistically using ANOVA. The results of this study were showed significant effect were then tested by Duncan's test [17].

#### Table 1. The composition materials and nutritional of quail feeding used in the treatment

| Feed Ingredients | \( L_0=0\% \) | \( L_1=1\% \) | \( L_2=1.5\% \) | \( L_3=2\% \) |
|------------------|---------------|---------------|----------------|---------------|
| Corn (%)         | 38.4          | 35.1          | 39.8           | 40.3          |
| Rice bran (%)    | 28.4          | 32.6          | 27.7           | 27.7          |
| Coconut grout (%)| 6.1           | 5.2           | 4.9            | 4.9           |
| Feather meal (%) | 0             | 1             | 1.5            | 2             |
| Fish meal (%)    | 4             | 5             | 6              | 6             |
| Soybean meal (%) | 23            | 21            | 20             | 19            |
| Mineral mix (%)  | 0.1           | 0.1           | 0.1            | 0.1           |
| Total            | 100           | 100           | 100            | 100           |

#### Feed Nutrient Components

- Protein (%)*: 20 20 20 20
- Metabolism energy (Me) (kcal/kg)**: 2489.34 2441.83 2535.68 2541.68
- Water (%)*: 11.30 11.02 11.21 11.16
- Ash (%)*: 5.82 6.41 6.33 6.34
- Fat (%)*: 5.82 6.10 5.86 5.90
- Fiber (%)*: 4.76 5.16 4.79 4.83

*Source: *Animal Feed Chemistry Laboratory, Faculty of Animal Science, Hasanuddin University ; **Research article [16].

### 3. Results

The results of the evaluation of biological responses to quail (*Coturnix coturnix*) given hydrolyzed feather meal treatment were presented in Table 2.

#### Table 2. Biological response of quail (*Coturnix coturnix*) given feather meal hydrolyzed at different level

| Parameter                | \( L_0=0\% \) | \( L_1=1\% \) | \( L_2=1.5\% \) | \( L_3=2\% \) |
|--------------------------|---------------|---------------|----------------|---------------|
| Body weight gain (BWG) (g/head/day) | 2.05±0.47     | 2.00±0.19     | 2.10±0.22      | 2.37±0.19     |
| Feed intake (FI) (g/head/day)          | 15.44±0.55    | 15.16±1.07    | 14.84±0.36     | 15.79±1.64    |
| Feed conversion (FC)          | 0.68±0.14     | 0.66±0.02     | 0.62±0.04      | 0.60±0.03     |
| Protein digestibility (PG) (%) | 47.16±19.35   | 40.48±18.67   | 51.69±10.87    | 40.55±17.25   |

### 3.1. Body weight gain

The body weight gain is the difference between the final weight with the first weight at a given time. Based on the results of the analysis of variance (ANOVA), it was shown that the difference in the level of use of feather meal hydrolyzed up to the limit of 2% in quail rations did not have a significant effect on the BWG. In general, the BWG of quail is in the range of 2.00-2.37 g/ head/day. The growth curve of the body weight of the quail during maintenance was presented in Figure 1.
The BWG is one of the criteria in measuring growth [18]. Based on Figure 1, it can be seen that the increase in the BWG of quail (\textit{Coturnix coturnix}) has increased from week 1\textsuperscript{st} to week 4\textsuperscript{th}. The highest body weight (BW) was quail given by L\textsubscript{3} treatment (2%), which was 105g. The lowest body weight is L\textsubscript{1} treatment. Based on the graph, the increase in the final BW to 30 days of production has similarities, namely L\textsubscript{0} (94.1g), L\textsubscript{1} (92.3g) and L\textsubscript{2} (96.1g), but for L\textsubscript{3} it looks higher than the others.

The BWG is one of the important parameters to reduce slaughtering age. This is related to the need for feed costs of quails [19]; [20]. The BWG Body in quails shows the ability to change feed substances contained in animal feed to be converted into meat. The BWG indicates an increase in the number and size of individual cells [21]. The speed of growth has a very large variation depending on the type of livestock, gender, age, strain, management, ambient temperature, feed quality and quantity.

3.2. Feed intake
The response of livestock to feed intake (FI) is the amount of feed consumed by livestock if the feed ingredients are given ad libitum. The FI is a basic factor for life and determines production. The FI was influenced by external (environmental) and internal factors [22]. These factors include environment, palatability, physiological status, nutrient concentration, form of feed and BW. The results of the ANOVA (Table 2) showed that the treatment of broiler feather meal on quail with different levels to a level of 2% had no significant effect (P>0.05) on the response to the FI. This can be caused the range of the level of giving very close, so it does not show a real effect.

High production performance is the result of higher feed intake, better digestion process and maximum absorption of nutrients. In addition, intestinal health and resistance to systemic challenges or a combination of both will improve production performance. Additives added to feed have a direct or indirect effect on improving the integrity of the intestinal epithelium [23].

The amount of nutritional needs in each day is very dependent on the type of animal, age, phase (growth, pregnant, breastfeeding), body condition (normal, sick) and the environment in which it lives (temperature, humidity, air relative) and body weight. Therefore, each animal with a different condition will need different feeds.

3.3. Feed conversion
Feed conversion is a comparison between the amount of feed consumption and body weight gain in a certain time unit. Feed conversion related to feed efficiency (FE). The FE value shows the ability of cattle to change feed into weight. This value is a very important economic principle [24]. The smaller conversion value indicates that the livestock is more efficient at converting feed into meat. The results of the study (Table 2) showed that increasing the level of use of feather meal showed no significant
effect on the feed conversion (P>0.05). Feed conversion value in this study (0.60-0.68) was not much different from the value of FE in Japanese quail results of the study [25] which is 0.48-0.52.

Improvement of feed conversion can be done by selecting livestock with the same feed requirements but higher weight gain. One of the main factors that influence feed conversion is genetic, ration quality, disease, temperature, cage sanitation, ventilation, treatment, and cage management. Feeding and lighting also play a role in influencing feed conversion. The rate of travel rations in the digestive tract, the physical form of the ration and the composition of nutrients in the ration are also factors that influence the value of feed conversion [26].

3.4. Protein digestibility

Digestion is substances from consumption of feed that is not excreted into feces. The amount of feed that can be digested is the difference between the food substances consumed and those excreted into the feces. Therefore, digestibility is the ability of a feed ingredient to be used by livestock. The high and low digestibility of feed ingredients will provide an overview of the amount of digestible food substances in the digestive tract of cattle. The extrusion process affects the process of protein degradation and interaction between components. This will affect the level of protein digestibility [27].

Table 2 shows the quail protein digestibility treated with hydrolyze feathers meal at different levels. The results of ANOVA showed that giving different levels of feather meal to the level of 2% in quail feed concentrate had no significant effect (P>0.05) on the protein digestibility. This can be caused by a range of levels of giving feather meal that is too close to show no real difference. Vegetable proteins such as nuts and cereals have a low digestibility in vitro. This is related to lower nutritional value [28].

The difference in digestibility values is caused by differences in the nature of the processed feed. This is related to the suitability of the hydrolysis process carried out by the livestock digestive system. Other factors that can affect digestibility are (1) the level of proportion of ingredients in the ration, (2) chemical composition, (3) level of protein ration and (4) mineral content, (5) physical form of feed ingredients, (6) fat, (7) feed deficiency and (8) antinutrients. Based on these data it can be seen that the highest level of protein digestibility in giving feather flour is 1.5% (L2). Protein digestion is a gradual process. The process of incomplete protein degradation can occur at the beginning of the process. This can affect the overall protein digestion process [29]. Differences in processing methods cause variations in protein digestibility [30].

4. Conclusion

The introduction of hydrolyzed broiler feather meal up to level 2% for 30 days in feed does not effect on the biological response (body weight gain, intake, feed conversion and feed digestibility) in quail (Coturnix coturnix), but can increase body weight higher than 0% (control), 1% and 1.5%.

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References

[1] Senkoylu N, Samli H E, Akyurek H, Agma A and Yasar S 2005 J. Appl. Poult. Res. 14 542-547.
[2] Bolton T 2015 The state of the South African Poultry Industry. Super Mark Retail pp 17-23.
[3] Khosravi H, Mehri M, Bagherzadeh-Kasmani F and Asghari-Moghadam M 2016 Anim Feed Sci Technol. 212 122-8.
[4] Sarmwatanakul A and Bamrongtum B 2000 Aquarium Fish Nutrition. Extension paper No.1/2000 (Bangkok: Ornament Fish Research and Public Aquarium)
[5] Arunlertaree C and Moolthongnoi C 2008 J. Env and Nat. Res. 6(1): 13-24.
[6] Said M I 2014 Product Ternak. Teknologi dan Aplikasinya. (Bogor: IPB Press).
[7] Said M I, Abustam E, Farida N Y F N and Mide M Z 2018a OnLine Journal on Biological Sciences 18 138-146.
[8] Said M I, Abustam E, Pakiding W, Mide MZ, Sukma M 2018b OnLine Journal on Biological Sciences 18 270-276.
[9] Silva L P, Ribeiro J C, Crispim A C, Silva F G, Bonafe C M, Silva F F and Torres R A 2013 Livest. Sci. 153: 27–32.
[10] Ikhlas B, Huda N and Noryati I 2011 Int. J. Poult. Sci. 10 30–37.
[11] Galíndez R, De Basilio V, Martínez G, Vargas D, Uztariz E and Mejia P n embryonic mortality in japanese quails (Coturnix coturnix japonica). Zootec. Trop. 28 17–24.
[12] Purohit A S, Reed C and Mohan A 2016 LWT-Food Sci. Tech. 69 447–453.
[13] Randall M and Bolla G 2008 Raising Japanese quail. 2nd ed. p 1e5. Primefacts 602.
[14] Wickramasuriya S S, Yi YJ, Yoo J, Kang NK and Heo JM 2015 A review of canola meal as an alternative feed ingredient for ducks. J Anim Sci Technol. 57:29.
[15] Rezaeipour V, Barsalani A and Abdullahpour R 2016 Trop Anim Health Prod. 48 1141-1146.
[16] Abun D, Saefulhadjar dan Haetami K 2012 Jurnal Ilmu Ternak. 2 1-6.
[17] Steel R G D and Torrie J H 1991 Principle and Procedure of Statistics. 2nd ed. (Tokyo: International Book Company)
[18] Tillman A D, Hartadi H, Reksohadiprodjo S, Prawirokusuma S dan Lebdosekoekojo S 1998. Ilmu Makanan Ternak Dasar. Gadjah Mada University Press. Yogyakarta.
[19] Barbieri A, Ono R K, Cursino L L, Farah M M, Bertipaglia T S, Pires A V, Cavani L, Carreño OD and Fonseca R 2015 Poult. Sci. 94 169–171.
[20] Aggrey S E, Ankra-Badu G A and Marks H L 2003 Poult. Sci. 82:538–542.
[21] Rose S P 1997 Principles of Poultry Science (England: Cab International).
[22] Nawab A, Ibtisham F, Li G, Kieser B, Wu J, Liu W, Zhao Y, Nawab Y, Li K, Xiao M and An L 2018 Journal of Thermal Biology. 78 131-139.
[23] Van-der-Aar P J, Molist F and van der Klis J D 2017 Animal Feed Science and Technology. 233 64-75.
[24] Blankenship K, Gilley A, Piekarski A, Orlowski S, Greene E, Bottje W, Anthony N and Dridi S. 2016 Neuropeptides 58 31-40.
[25] Vargas-Sánchez R D, Torrescano-Urrutia G R, Ibarra-Arias F J, Portillo-Loera J J, Ríos-Rincón F G and Sánchez-Escalante A 2018 Livestock Science. 207 117-125.
[26] Case L, Wood B and Miller S 2012 Genet. Sel. Evol. 44: 1–4.
[27] Zhang B, Liu G, Ying D, Sanguantri L and Augustin MA 2017 Food Research International. 100 658-664.
[28] Carbonaro M, Maselli P and Nucara, A 2012 Amino Acids. 43(2) 911-921.
[29] Uni Z, Noy Y, Sklan D 1996 Br. Poult. Sci. 37 63-71.
[30] Elkin R G 2002 Nutritional components of feedstuffs: a qualitative chemical appraisal of protein In: McNab J M., Boorman K N (Eds.) Poultry feedstuffs: supply, composition and nutritive value (London: CABI Publishing) pp. 57-86.