Performance and characteristics of digestive tract organs given *Indigofera zollingeriana* leaf meal and turmeric (*Curcuma domestica*) on Japanese quail

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Abstract. Feed material that can be used as a substitute for soybean meal for quail livestock, one of which is *Indigofera zollingeriana* flour which has a crude protein content of 22-29% and turmeric added as natural antibiotics can increase quail performance. The aim of this study was to investigate the effects of *Indigofera zollingeriana* top leaf meal as substitution of soybean meal and turmeric added as a substitute for antibiotic on quail performance and the characteristics of the optimal digestive system. One hundred and sixty Japanese quail (*Coturnix coturnix japonica*), at 7 weeks old were used in this study and kept in insulation cages. A randomized completely design was applied with four dietary treatments and five replications. Control diet, without *Indigofera zollingeriana* top leaf meal and turmeric meal (P0), Substitute 6% soybean meal protein with 10% *Indigofera zollingeriana* top leaf meal and 2.5% turmeric meal (P1), Substitute 9% soybean meal protein with 15 % *Indigofera zollingeriana* top leaf meal and 2.5% turmeric meal (P2), Substitute 12% soybean meal protein with 20 % *Indigofera zollingeriana* top leaf meal and 2.5% turmeric meal. The ration used was isoprotein (20%) and isoenergy (2800 kcal kg⁻¹). Variable observed were feed intake, body weight gain, feed conversion, carcass percentages and the length and weight of the digestive tract. The result of this study was no significant among treatments (P>0.05) for feed intake, feed conversion, carcass percentages and digestive tract organs. However, body weight gains significant increased (P<0.05) were P2 not deferent with P0, P1, and P3, but P1 and P3 different bigger than P0. The conclusion of this study was substitute soybean meal protein with *Indigofera zollingeriana* top leaf meal and turmeric meal can increased quail body weight gain.

1. Introduction

Japanese quail (*Coturnix coturnix japonica*) or quail laying can also be used for meat. Japanese quail that are usually used are female rejects or young males aged 40-42 days, but to get quails with high cutting weights at a young age effort need to be made to support the potential for rapid quail development. The use of commercial feed is considered able to support the potential of quail, but the use of commercially-made commercial feed with a balanced nutritional content has a relatively expensive price, so it is necessary to look for alternative components of feed that are more economically efficient.
Indigofera zollingeriana is considered capable of being an alternative feed material that can replace the use of commercial feed which has a relatively high price. Several studies on the use of Indigofera as a substitute for soybean meal substitution on poultry performance have been conducted [1] and show the potential use of Indigofera with high protein content in poultry.

Provision of feed additives is another effort made to increase the productivity of poultry. Feed additives or feed additives can be in the form of feed additives (additives) to improve the performance of livestock production. The use of antibiotics is a practical solution. However, seeing the negative impact that can be caused by the use of synthetic antibiotics, Indonesia has banned the use of various types of antibiotics, related to the contamination of harmful residues for consumers and certain bacterial resistance [2]. Recent bans on the use of antibiotics [3] prohibit the use of antibiotics as growth promoters. Therefore, it is necessary to add feed additives from natural ingredients that do not cause any adverse effects.

Turmeric (Curcuma domestica) has been given to various types of poultry as feed additives, various studies have been carried out to improve feed efficiency and productivity of poultry [4] and [5]. The use of turmeric as a feed additive, because the active ingredients contained are able to provide anti-inflammatory and anti-microbial effects, so they are able to become natural antibiotics [6]. Turmeric contains curcumin and essential oils, this active compound of curcumin has an antibacterial activity contributing to the health and development of the digestive tract [7] further explained that the use of turmeric extract 2.5% in broilers can improve the health status of livestock.

Based on the description above, a study was conducted on the effect of giving Indigofera shoots (Indigofera zollingeriana) to substitute soybean meal and the addition of turmeric in feed on the performance and characteristics of quail organs. The purpose of this study was to determine the effect of Indigofera zollingeriana shoots as a substitute for soybean meal and administration of turmeric flour (Curcuma domestica Val) in feed on the performance and characteristics of organs in quail.

2. Material and methods
The study was conducted in May-July 2018, at the Non-Ruminant Nutrition Laboratory, Faculty of Animal Science, Hasanuddin University.

2.1. Material
The material used is quail (Coturnix coturnix japonica) as many as 160 days 7 days old, determination of mixed sex (unsexed), indigofera leaf buds (IF), turmeric flour, feed ingredients consisting of corn, bran, soybean meal, fish meal, feather meal, meat and bone meal, dicalcium phosphate, L-lysine, DL-methionine, drinking water and disinfectant fluids.

The cages used are iron-caged battery cages, totaling 20 plots with a size of 60 x 30 x 20 cm each. Each enclosure is equipped with a feed container, drinking water and a 20-watt incandescent lamp for heating. The equipment used was stationery, sitting scales, Weiheng digital scales load capacity of 500 g of 0.01 g sensitivity, ovens, filters, grinding machines, scissors, knives, sterile gloves, newspaper, and hand sprayers.

2.2. Methods
The design used was a completely randomized design (CRD) with 5 treatments and 4 replications so that there were 20 experimental units. Quail used 7 days old randomly divided according to treatment and unsexing into each experiment unit plot of 8 heads / plot. Each plot is labeled to make recording easier. Turmeric will be given into the ration as much as 2.5% [7]. The composition of the feed given as follows: P0: control feed; P1: Indigofera zollingeriana Leaf Flour 10% (equivalent to 6% substitution of soybean meal) + turmeric rhizome flour 2.5%; P2: Indigofera zollingeriana leaf top flour 15% (equivalent to 9% substitution of soybean meal) + turmeric rhizome flour 2.5%; P3: Indigofera zollingeriana leaf top flour 20% (equivalent to 12% substitution of soybean meal) + turmeric rhizome flour 2.5%.
2.2.1. *Indigofera* leaf flour production. The study began with the manufacture of *indigofera* leaf shoots which were harvested at 45 days, by cutting the shoots with a 3.14 cm round stem or having 4-5 upper leaf stalks [1]. Then dry in the sun for 6 hours. After drying the *indigofera* leaf buds are crushed with a grinding machine and sieved using a sieve to make flour to be mixed into the feed.

2.2.2. *Making turmeric flour*. Turmeric rhizomes are washed thoroughly with running water, then thinly sliced, then dried in the sun or using an oven at ± 60ºC for 2 days. After dry, smooth it with a grinding machine and sieve using a sieve to make flour then mixed into the feed.

2.2.3. *Feed preparation*. The ingredients of the feed consist of a mixture of feed ingredients: ground corn, bran, soybean meal, fish meal, feather meal, meat and bone meal, dicalcium phosphate, L-lysine, DL-methionine, mineral mix, turmeric flour, and *Indigofera zollingeriana*. Preparation of feed is done by using the standard requirements for quail starter based on [8].

2.2.4. Research procedure. Quail at the age of 7 days is placed in 20 plots with 20 plots of quail / plot. The cage is equipped with a feed, drinking water and heating using a 10-watt incandescent lamp. Heaters are provided at night for the initial 7 days of maintenance. Provision of drinking water is done in an ad libitum and water changes are carried out in the morning, the feed used is mixed feed, lighting 24 hours during the maintenance period. Performance parameters are measured at 14-42 days (4 weeks) during the quail maintenance period. The measured performance was: feed consumption, weight gain, feed conversion and carcass percentage. Measurement of absolute length of parts / organs of the digestive tract [9, 10].

2.3. Statistical analysis
Data for H/L ratio and lymphoid organ were subjected to an analysis of variance. The treatments means with significant differences at P<0.05 were compared using Duncan test.

3. Result and discussion
Based on the results of the study obtained the average feed consumption, body weight gain, feed conversion, carcass percentage (table 1) and characteristics digestive organs (*Coturnix-coturnix japonica*) (table 2) aged 14-35 days with substitution treatment soybean meal protein of *Indigofera zollingeriana* leaf buds with different levels and the addition of turmeric.

**Table 1.** Feed consumption, weight gain, feed conversion, and carcass percentage of japanese quail aged 35 days

| Treatments | Feed consumption (g/b/wk) | Body weight gain (g/b/wk) | Feed conversion | Carcass (%) |
|------------|----------------------------|--------------------------|----------------|------------|
| P0         | 104.51±7.73                | 20.36±1.34               | 5.12±0.26      | 62.26±2.68 |
| P1         | 107.17±11.88               | 22.60±1.81               | 4.72±0.18      | 59.31±2.89 |
| P2         | 105.61±10.94               | 20.78±1.37               | 5.08±0.51      | 60.10±4.15 |
| P3         | 102.00±16.67               | 22.76±1.28               | 4.48±0.73      | 59.20±2.51 |

a,b Different superscripts in the same column show differences in significance (P <0.05).

3.1. Feed consumption
Based on the results of the analysis of various soybean meal protein substitution with TPDI up to 20% and the addition of 2.5% turmeric flour did not affect (P> 0.05) consumption of Japanese quail feed. Similar result [1] that the substitution of *Indigofera* shoot flour to 45% of soybean meal protein did not affect the consumption of laying hens. The average feed consumption from highest to low, respectively P1, P2, P0, and P3. The high consumption of feed P1 and P2 compared to control can be caused by curcumin contained in turmeric which can act as an appetite enhancer. This is in accordance with the
The average quail feed consumption ranges from 102 – 107.17 g / e / week or equivalent to cumulative consumption of 408 - 428.63 grams per head. Research [12] with consumption of quail cumulative feed maintained for 35 days by feeding with an energy content of 2900 Kcal / kg and protein 24% (364.1 - 379.5 g/b) This may be due to different energy content where consumption feed will continue to increase along with the low metabolic energy content in the ration [13].

3.2. Body weight gain
Based on the results of statistical analysis of soybean meal protein substitution with IF and the addition of 2.5% turmeric flour gave an effect (P <0.05) on the weight gain of Japanese quail. Further tests showed P2 weight gain was not different from P0, P1 and P3, but P1 and P3 were significantly higher (P <0.05) than P0. This can be caused by the treatment of good quality protein based on the amino acid score of Indigofera zollingeriana which is almost the same as the soybean meal amino acid score. According to [1] the calculation of the amino acid score of shoots of Indigofera zollingeriana which is equal to 0.24 and the amino acid score of soybean meal is 0.26. It was further explained that the amino acid score or chemical score is the degree of efficiency in the use of protein for the synthesis of body protein, so that it can be estimated the proportion of protein that is owned by feed ingredients to build body tissue. Another thing that might cause this increase is caused by the addition of turmeric in the feed, thereby increasing the work of the digestive organs. According to [4] turmeric contains active compounds that increase digestion and absorption of some nutrients in food, namely curcumin and curcuminoid which cause an increase in the efficiency of feed use so as to increase broiler growth. In line with research [5] that the administration of turmeric powder in feed showed increased levels of protein in meat so that the efficiency of feed increased.

The content of active substances such as essential oils, curcumin and oleoresin in turmeric can stimulate the secretion of digestive enzymes and inhibit the growth of pathogenic bacteria, so that the growth of non-pathogenic bacteria is more optimal which in turn can maintain the health of villi [6]. The average weight gain of Japanese quail maintained for 35 days is 20.36 3622.76 g/bird/week equivalent to the cumulative consumption of 89.88-99.55 g/bird. These results are still smaller with the results of research [12] with the increase in quail weight given 111.9 g/b/week commercial feed with cumulative consumption of 364 - 379 g/bird, as well as the study [14] showing the increase in quail weight who were given commercial feed 27,688 g/bird/week. This difference may be caused by the use of different types of feed, so the impact on consumption, this is in accordance with the opinion. Another thing that might cause differences due to different protein content between commercial feed with 21-23% protein and 20-22% with mixed feed used with 20% protein content, this is in accordance with the opinion [15] that the feed containing higher protein than others tends to provide a higher body weight gain.

3.3. Feed conversion
Based on the analysis of variance it is known that no effect (P> 0.05) on feed conversion. The lowest conversion rate to successive high, namely: P3, P1, P2, P0. These results indicate a decrease in the value of feed conversion along with treatment feed. This result may be due to differences in feed consumption and body weight gain caused by differences in nutrient content in feed. [16] that the relationship between feed consumption and weight gain is determined by feed conversion, low feed conversion values indicate better feed use efficiency. The same thing was stated in the research of [17] that the addition of cumin and turmeric mixture at the level of 0.75% to 1% as a feed additive in feed to broilers can improve feed conversion and [18] 0.9% turmeric in feed has an impact on improving broiler feed conversion.

3.4. Carcass percentage
Variance analysis results showed that soybean meal protein substitution with TPD1 up to 20% and the addition of 2.5% turmeric flour did not affect (P>0.05) percentage of quail carcass. The results of this
study showed that P0 was 110.95 grams with 68.88 grams carcass weight and 62.26% carcass percentage, while P1 was 114 grams with carcass weight 67.59 grams and carcass percentage was 59.31%. Carcass weight is influenced by the weight of life, so that a large weight of life will be followed by a large weight of carcass as well.

The average value of the smallest to largest percentage of carcasses, namely P3, P1, P2, and P0. The small percentage of quail carcass value in the feeding treatment compared to control may be caused by an increase in internal organs so that the percentage of carcasses has decreased [19]. The increase in the weight of the digestive tract can be caused by the administration of turmeric and an increase in the level of administration of Indigofera and fiber content in the feed. This is consistent with the research of [20] which shows that increasing fiber in feed can increase the weight of gizzard, small intestine (duodenum, jejunum, and ileum), and cecum, as the increase in fiber content in feed on broiler chickens. The same thing was reported [21] that as the increase in crude fiber content in broiler feed will increase heart weight and gizzard.

3.5. Characteristic of digestive tract organ

The effect of the treatment on the characteristics of the length of the quail digestive organs given Indigofera zollingeriana and turmeric can be seen in table 2. Based on the results of the analysis of variance shows that the treatment ration showed no significant effect (P> 0.05).

| Table 2. Quail digestive organ length (cm) resulting from Indigofera zollingeriana flour and turmeric. |
| Organ length (cm) | Treatments |
|-------------------|------------|
|                   | P0         | P1         | P2         | P3         |
| Oesophagus        | 5.19±1.32  | 4.12±0.60  | 3.58±0.67  | 4.19±0.76  |
| Proventriculus    | 1.69±0.26  | 1.64±0.17  | 1.50±0.13  | 1.65±0.19  |
| Duodenum          | 11.42±1.52 | 12.49±1.16 | 11.07±0.70 | 12.86±1.49 |
| Jejunum           | 27.05±4.01 | 24.65±5.02 | 25.42±1.07 | 25.02±1.74 |
| Ileum             | 17.87±2.17 | 16.94±2.65 | 17.41±1.37 | 16.70±0.89 |
| Caecum            | 7.10±2.32  | 7.13±0.97  | 6.20±0.34  | 7.05±0.62  |
| Colon             | 4.70±0.41  | 5.22±0.48  | 3.93±0.56  | 4.05±0.25  |

The absence of changes that occur in the oesophagus due to the possibility because the oesophagus only continues the food so that it is immediately stored in the cache. In addition, there is no long change in the oesophagus due to the food consumed has a size that can still be swallowed by the oesophagus. Yuwanta [22] argues that the oesophagus produces mucosa which serves to help smooth food into the cache. The oesophagus is a soft and elastic duct that is prone to expansion when there are boluses that enter.

The results of the study were also thought to be due to Indigofera zollingeriana and turmeric which contained crude fiber but had not affected proventricular activity in the formation of stomach acid so that it was still tolerable. Blakely and David [23] suggested that proventriculus secretes gastric acid and pepsin enzymes that function to break down proteins into amino acids. The function of turmeric in improving the work of the digestive organs of poultry is to stimulate the walls of the gallbladder to release the bile and to stimulate the release of pancreatic sap containing amylase, lipase, and protease enzymes that are useful for improving digestion of feed ingredients such as carbohydrates, fats, and proteins. Numerically, the length of duodenal P3 treatment shows a greater number than the control and other treatments, this is probably due to the addition of turmeric in the feed which causes the work of duodenal organs to increase. Curcuminoid from turmeric extract is mostly in the form of curcumin which has uses as an antioxidant. Purwanti et al. [7] that turmeric powder contains curcumin active ingredient which functions as an appetite enhancer. The administration of Indigofera zollingeriana and turmeric has not shown a significant effect on the length of the jejunum and ileum. It is suspected that coarse fiber in Indigofera zollingeriana can still be tolerated by the intestine in the process of protein absorption.
Numerically, the caecum of P1 treatment is longer than that of other treatments, this is presumed because in the treatment of P1 the caecum channel has a greater performance than the caecum in other treatments in processing the absorption of fat and crude fiber, thereby triggering an increase in microbial activity in caeca. The function of the cecum is absorbing water, and digesting carbohydrates and protein with the help of bacteria in it.

The administration of indigofera shoot flour has not shown a significant effect (P > 0.05) on the length of the large intestine. This is presumably because the antinutrients in Indigofera zollingeriana and turmeric can still be tolerated. Numerically, the P1 treatment was longer than the other treatments, this might be due to the treatment of P1, the organ performance in the absorption of crude fiber was greater. Feed that contains a lot of fiber and other undigested materials such as small rocks causes changes in the size of parts of the digestive tract, so that the intestine is heavier, longer, and thicker (24).

4. Conclusion
The conclusion that the substitution of soybean meal protein with 20% Indigofera zollingeriana leaf top flour and the addition of 2.5% turmeric flour in the feed can increase quail weight gain and does not have a negative effect on the characteristics of the quail digestive organs.

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