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Effect of Different Commercial Feeds on Small Intestine Morphometry and Histomorphometry of Alope Chickens

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ABSTRACT

Each commercial feed has different nutritional compositions that may affect the productivity and digestive tract condition of Alope chickens. This study aimed to evaluate the effect of different commercial feeds on the morphometry and histomorphometry of the small intestine in Alope chickens. The experiment was conducted using a Completely Randomized Design with four treatments and three replications: P1 (Commercial Feed X1), P2 (Commercial Feed X2), P3 (Commercial Feed X3), and P4 (Commercial Feed X4). Parameters were small intestine morphometry, weight of the duodenum, jejunum, and ileum and small intestine histomorphometry. The results showed that different commercial feeds had no significant effect (P>0.05) on intestinal morphometry, except for the weight and length/weight ratio of the jejunum. Conversely, there was a significant effect (P<0.05) on the histomorphometry of the jejunum and ileum. The P3 treatment produced the best results and is recommended as the most effective feed to support small intestine development in Alope chickens.

Keywords: Commercial Feed; Alope Chicken; Morphometry; Histomorphometry; Small Intestine

1. Introduction

Alope chicken is an improved local chicken developed through the selection of native chickens in South Sulawesi, which has undergone up to six generations of selection. This chicken was developed by the Faculty of Animal Science, Hasanuddin University, through the application of the in ovo feeding technique, as described by [1], this technique involves the injection of nutrients into the egg during incubation to promote optimal embryonic development, which subsequently exerts a positive effect on the post-hatch performance of the chicks.

Feed constitutes a major factor in the management of chickens, accounting for approximately 60–70% of the total production cost. Therefore, feed quality and nutrient composition should be considered a primary concern. Appropriate feeding management is essential to enhance growth performance and overall productivity in chickens [2]. Commercial feeds are widely used because they are formulated to meet the complete nutritional requirements of poultry. However, the formulation of each commercial feed product varies according to the ingredients used [3], which may influence both the nutritional profile and productive performance of the animals.

Differences in feed composition are closely associated with chicken productivity, which is largely influenced by the condition of the digestive tract, particularly the small intestine. As the principal organ responsible for digestion and nutrient absorption, the small intestine plays a pivotal role in determining the efficiency of nutrient utilization from the feed. Optimal absorption can be achieved only when the digestive tract is in a healthy physiological state. Indicators of small intestinal health include its weight, length, and villus morphology, all of which directly contribute to improved digestive efficiency and growth performance in chickens [4]. The structural integrity of the small intestine is therefore considered a key parameter for assessing digestive system effectiveness in poultry [5]. Variations in feed formulation and nutrient composition may alter intestinal morphology, ultimately affecting growth performance and overall health in chickens [6].

However, studies evaluating the effects of different commercial feeds on the morphometric and histomorphometric characteristics of the small intestine in Alope chickens remain limited. Therefore, this study was conducted to investigate the influence of various commercial feed formulations on the small intestinal morphology of Alope chickens, with the aim of identifying feed types that best support intestinal health and growth performance.

2. Method

2.1. Place

This research was conducted at the Poultry Production Laboratory, Livestock Reproduction Laboratory, Faculty of Animal Science, Hasanuddin University, Makassar, and Veterinary Center (BBVet), Maros.

2.2. Materials

The equipment used in this study included individual cages, analytical scales, incubators and hatchers, thermometers, hygrometers, feeders, lamps, nipple drinkers, plastic containers, surgical knives, writing instruments, microscopes, glass slides, cover slips, and a camera. The materials used consisted of 12 Alope chickens, four types of commercial feed (X1, X2, X3, and X4), disinfectants, vitamins, medicines, vaccines, 10% formalin, water, and label paper.

Table 1. Proximate nutrient composition of commercial feeds X1, X2, X3, and X4

Commercial Feed	Nutrition Content						
	Water (%)	CProtein (%)	CFat (%)	CFiber (%)	EM (kkal/kg)	BETN (%)	Ash (%)
X1	10,94	23,73	5,36	3,82	3600,43	60,96	6,13
X2	11,99	23,01	5,28	3,85	3608,53	61,97	5,88
X3	13,27	23,82	3,55	2,75	3530,24	62,80	7,09
X4	10,86	22,73	5,46	3,22	3639,79	62,64	5,93

Source: Feed chemistry laboratory analysis, Faculty of Animal Science, Hasanuddin University

2.3. Research design

The research was conducted using an experimental approach with a Completely Randomized Design (CRD) consisting of four treatments and three replications. The treatments were as follows:

P1: Commercial feed X1 P2: Commercial feed X2 P3: Commercial feed X3 P4: Commercial feed X4

2.4. Research procedure

- Housing and Equipment Preparation.

Two types of housing were used in this study: a brooding pen and individual cage units (12 compartments). During the brooding phase (1–3 weeks), the chicks were kept in a pen measuring 200 × 100 cm equipped with a heater, feeders, and drinkers. Temperature and lighting were controlled according to the age of the chicks to ensure uniform growth and prevent stress. In the grower phase (4–10 weeks), the chickens were transferred to individual cages (30 × 50 cm) with slatted plastic floors to allow for better waste separation and health monitoring. Each cage was equipped with an individual feeder and nipple drinker to maintain feed and water hygiene.

- DOC Preparation

Alope chicken eggs were disinfected, selected, fumigated, and stored before incubation. Eggs were placed in a setter for 18 days, then candled to separate fertile from infertile and dead eggs. Fertile eggs were transferred to the hatcher for 3 days. On day 21, hatched chicks were weighed, vaccinated against Newcastle Disease (ND) via eye drops, and selected for rearing. Only healthy and uniformly sized chicks were used to minimize variation among experimental units.

- Management of Rearing

Twelve male Alope chickens were reared for 70 days. At 21 days of age, the chicks were randomly assigned to individual cages under four treatments with three replications. The rearing period consisted of two phases: a brooding phase (group housing) for 3 weeks and an individual cage phase for 7 weeks. During brooding, chicks were fed according to treatment using chick feeders and hanging tube feeders, with water provided ad libitum via nipple drinkers. Daily management included cleaning feeders and drinkers, recording feed intake, and maintaining litter dryness to prevent disease. At week 10, morphometric and histomorphometric measurements of the small intestine were carried out.

2.5. Observed Variable

1. small intestine morphometry

Observations were made by calculating the length, weight, and length-to-weight ratio of each duodenum, jejunum, and ileum.

- The length of the duodenum, jejunum, and ileum was measured using a ruler to obtain the length of each section of the intestine in centimeters (cm).
- The weight of the duodenum, jejunum, and ileum was measured using an analytical scale to obtain the weight of each intestinal segment in grams.
- The length-to-weight ratio of the duodenum, jejunum, and ileum, which is the small intestine morphological ratio, can be calculated using the formula:

$$Length - to - weight\ ratio = \frac{Length\ (cm)}{Weight\ (g)}$$

- The relative weight of the duodenum, jejunum, and ileum was calculated by dividing the weight of each small intestinal segment by the body weight and then multiplying by 100%. The percentage of each segment relative to body weight was determined using the following formula:

$$\text{Percentage of duodenal weight (\%)} = \frac{\text{Duodenal Weight Total}}{\text{small intestine weight}}\ x\ 100\%$$

$$\text{Percentage of jejunal weight (\%)} = \frac{\text{jejunal Weight}}{\text{total small intestine weight}}\ x\ 100\%$$

$$\text{Percentage of ileal weight (\%)} = \frac{\text{ileal Weight}}{\text{total small intestine weight}}\ x\ 100\%$$

2. Small intestine histomorphometry

Observations were conducted to measure villus height, villus width, and villus surface area in the jejunum and ileum using a light microscope equipped with a digital camera connected to Nikon NIS-Elements Imaging Software (Japan).

2.6. Data analysis

The data obtained were analyzed using analysis of variance (ANOVA) based on a Completely Randomized Design (CRD) consisting of four treatments and three replications. The mathematical model used was as follows:

$$Yij = \mu + \alpha i + \varepsilon ij$$

Description:

$Yij = observation\ value\ of\ the\ i-th\ treatment\ and\ j-th\ replication$

$\mu = overall\ mean$

$\alpha i = effect\ of\ the\ i-th\ treatment$

$\varepsilon ij = experimental\ error\ associated\ with\ the\ i-th\ treatment\ and\ j-th\ replication$

Differences among treatment means were further tested using Duncan's Multiple Range Test (DMRT) when significant effects were detected.

3. ***Result and Discussion***.

3.1 Morphometry of the small intestine

Morphometry refers to macroscopic measurements conducted using a ruler and an analytical balance. The measurements included the length, weight, length-to-weight ratio, and relative weight percentage of each segment of the small intestine, namely the duodenum, jejunum, and ileum. These parameters are important indicators of intestinal development, as changes in size or proportion may reflect adaptation to nutrient absorption efficiency and digestive activity. A longer and heavier intestine segment generally indicates better intestine development and higher absorptive capacity. Therefore, evaluating intestinal morphometry provides valuable insight into how different feed compositions influence the digestive physiology of Alope chickens. The following section presents the results of the study on the effect of different commercial feeds on the small intestine morphometry of Alope chickens.

Table 2. Morphometry of the small intestine of male Alope chickens with different commercial feeds

Parameters	Treatments			
	P1	P2	P3	P4
Length (cm)				
Duodenum	21.23±1.86	20.46±5.04	19.03±1.79	17.70±5.85
Jejunum	44.13±6.30	46.23±7.35	43.20±5.74	47.43±8.50
Ileum	39.93±9.34	39.26±5.49	41.16±4.75	42.23±11.1
Weight (g)				
Duodenum	6.86±1.81	7.10±1.13	9.30±1.77	6.23±1.23
Jejunum	11.10±0.10^{a}	10.76±1.10^{a}	15.76±1.43^{b}	11.83±2.72^{a}
Ileum	8.36±1.30	8.66±0.90	11.86±1.58	8.70±2.04
Length-to-weight ratio				
Duodenum	3.23±0.72	2.90±0.70	2.06±0.32	2.80±0.40
Jejunum	4.00±0.62^{b}	4.33±0.81^{b}	2.73±0.25^{a}	4.10±0.55^{b}
Ileum	4.93±1.92	4.60±1.13	3.50±010	4.83±0.75
Weight percentage				
Duodenum	26.00±6.35	26.80±4.66	25.06±1.45	23.4±2.72
Jejunum	42.16±1.36	40.53±2.30	42.80±1.65	44.13±2.58
Ileum	31.83±5.35	32.60±2.43	32.13±0.40	32.36±0.80

Superscripts with different letters indicate significant differences (P<0.05)

The analysis of variance showed that different commercial feeds had no significant effect (P > 0.05) on the morphometric parameters of the small intestine in Alope chickens, except for jejunal weight and the jejunal length-to-weight ratio. Based on Duncan's multiple range test, treatment P3 differed significantly from P1, P2, and P4. This variation indicates a physiological response to the crude fiber content in the feed, where a high-fiber diet promotes intestinal elongation as a form of digestive adaptation. This finding is consistent with [7], reported that higher crude fiber levels are associated with increased small intestine length. This also indicates that the jejunum is more sensitive to variations in feed composition compared to other intestinal segments, such as the duodenum and ileum. The jejunum serves as the primary segment of the small intestine responsible for nutrient absorption in chickens. This is consistent with the findings of [8] and [9], who reported that the majority of nutrient absorption in poultry occurs within the jejunal segment.

This study demonstrates that the length and weight of the small intestine are not always directly proportional. This finding contrasts with [10], who reported a positive correlation between intestinal length and weight, indicating that a longer intestine tends to have greater mass. The present results suggest that intestinal length does not necessarily reflect its physiological capacity. Treatment P3, which contained the highest protein and nitrogen-free extract (NFE) levels with the lowest fiber and fat content, may have supported optimal development of other factors such as enzymatic activity, mucosal histology, and villus morphology [11], contributing to increased intestinal tissue mass as a physiological response.

However, the lack of statistical significance was likely due to the minimal differences in nutritional composition between treatments, which were insufficient to affect intestinal length. [12] noted that dietary protein plays a key role in small intestine development. In this study, protein and crude fiber levels were relatively similar across treatments, resulting in no significant variation. Additionally, the physical form of the feed—pellet, crumble, or mash—can influence digestive organ development [13], as [4] also reported that feed texture affects digestive tract responses, particularly in the small intestine of native chickens. The physiological adaptability of Alope chickens, resulting from genetic selection, may lead to a relatively uniform growth response of the digestive organs, thereby minimizing structural variation among treatments. Native chickens are known for their high adaptability to different feed types and environmental conditions [14], so minor differences in feed composition are unlikely to significantly affect the small intestine length of Alope chickens.

3.2 Histomorphometry of the small intestine

Histomorphometry refers to microscopic measurements conducted using a light microscope, including villus height, width, and surface area in the jejunal and ileal segments. The following are the results of the study on the effect of different commercial feeds on the small intestine histomorphology of Alope chickens.

Table 3. Histomorphometry of the small intestine of male Alope chickens with different commercial feeds

Parameter	Treatments			
	P1	P2	P3	P4
Jejunum	401.11±80.18^{a}	572.16±151.04^{a}	1556.45±262.30^{b}	737.55±199.79^{a}
Ileum	352.26±21.09^{a}	644.34±266.97^{ab}	1230.27±233.47^{c}	881.35±288.34^{bc}
Villus width (µm)				
Jejunum	114.30±24.85^{a}	200.88±50.75^{a}	400.04±87.64^{b}	191.28±46.45^{a}
Ileum	149.00±17.92^{a}	208.17±16.07^{a}	326.97±27.43^{b}	311.90±96.84^{b}
Villus surface area (µm)				
Jejunum	24504.89±11193.23^{a}	52574.67±20023.88^{ab}	307491.35±30312.20^{c}	99471.47±51288.21^{b}
Ileum	19964.58±1936.78^{a}	66490.33±20592.27^{a}	220108.55±21902.50^{b}	173907.61±102456.52^{b}

Superscripts with different letters indicate significant differences (P<0.05)

Analysis of variance showed that the type of commercial feed significantly affected (P<0.05) the histomorphometry of the small intestine in Alope chickens. These results indicate that variations in commercial feed influence the structure of intestinal villi, confirming that differences in nutrient composition significantly affect the small intestine's structural characteristics.

The P3 treatment consistently resulted in superior villi characteristics compared to the other treatments. These effects are likely due to the nutrient composition of the P3 feed, as shown in Table 1. The P3 treatment had the highest crude protein (CP) and nitrogen-free extract (NFE) content, along with the lowest crude fat (CF) and crude fiber (CF) levels. This indicates sufficient protein and carbohydrate availability, with reduced fiber and fat, creating an optimal intestinal environment that supports villi development. The high crude protein content in feed supports cell synthesis and tissue growth. This is also stated by [15], who reported that feed with high protein content can increase cell growth, which will have an impact on optimal villi growth. On the other hand, BETN content, as a source of easily digestible carbohydrates, also plays an important role in providing energy for villi cell proliferation. [16] reported that treatment with low carbohydrate levels resulted in the lowest villi characteristics.

The low crude fiber and fat content in P3 feed likely reduces the digestive burden on the intestines, allowing more energy and nutrients to be allocated to villi maintenance and growth. High levels of indigestible fiber can increase intestinal workload and reduce nutrient absorption efficiency, thereby inhibiting optimal villi development [17]. Moreover, the presence of antinutritional factors may also negatively affect villi development [18]. Furthermore, villi characteristics, such as increased surface area, may correlate with higher activity of digestive enzymes bound to the microvilli, positively impacting nutrient availability for chicken growth and maintenance and ultimately enhancing growth performance. This aligns with the findings of [19], who concluded that increased small intestine enzyme activity positively influences villi growth and development.

4. Conclusions

Based on the results, different commercial feeds did not have a significant effect (P>0.05) on the morphometry of the small intestine in Alope chickens, except for the jejunum weight and length-to-weight ratio, which showed significant differences. In contrast, analysis of variance revealed a significant effect (P<0.05) on small intestine histomorphometry, including villi height, width, and surface area in the jejunum and ileum. These findings indicate that while different commercial feeds may partially affect small intestine morphometry, they significantly influence overall histomorphometric characteristics. Therefore, P3 (commercial feed X3) is recommended as the most suitable feed for supporting optimal small intestine function in Alope chickens

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