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Performance and digestive organ profile of Wandering Whistling Duck fed different protein levels

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ABSTRACT

This study investigated the effects of different dietary protein levels on the performance and digestive tract profile of Wandering Whistling Ducks. A total of 108 5-month-old Wandering Whistling Ducks were reared intensively for three months (one-month rearing and feed adaptation period followed by two months of dietary intervention). The dietary treatments comprised of three protein levels: T1 12%, T2 15%, and T3 18%. Each treatment consisted of nine replications, with each experimental unit consisted of four Wandering Whistling Ducks. The parameters measured in this study were feed consumption, water consumption, feed-to-water ratio, body weight gain, relative weight and length of digestive organ, villus height, crypt depth, villus-to-crypt ratio, histopathological features, digestive tract pH, and ileal bacteria counts. The data were analyzed using analysis of variance followed by Duncan's multiple range test. The results indicated that dietary protein levels significantly affected feed consumption, body weight gain, ileal crypt depth, cecal lactic acid bacteria, and gizzard pH. Other parameters showed no significant response to different protein levels. Based on these findings, it was concluded that a dietary protein level of 18% yielded the most favourable outcomes in terms of growth performance and the digestive tract profile of Wandering Whistling Ducks

Keywords: *Dietary protein, Digestive organ, Intestinal histology, Performance, Waterfowls*

INTRODUCTION

The Wandering Whistling Duck (*Dendrocygna arcuata*) is a species of waterfowl that has not been widely domesticated. However, in Sidenreng Rappang, South Sulawesi, it is a key ingredient in a traditional regional dish. Historically, these ducks have been obtained through wild capture. According to the International Union for Conservation of Nature (IUCN), the Wandering Whistling Duck is currently classified as a species of Least Concern (BirdLife International, 2024). Despite this designation, the unprotected status of the species has led to continued hunting, resulting in a decline over recent years (BirdLife International, 2024).

A related species, the West Indian Whistling Duck (*Dendrocygna arborea*) in Malaysia, has seen its conservation status escalate to vulnerable, indicating a near-threatened status (MyBIS, 2024). A similar fate could befall *D. arcuata* if conservation measures are not implemented. One effective conservation strategy for *D. arcuata* is through domestication and cultivation. While some enthusiasts have begun breeding the Wandering Whistling Duck, efforts have largely been semi-intensive, with inadequate feeding practices, leading to suboptimal results.

To enhance productivity and ensure successful intensive rearing, it is critical to meet the nutritional needs of the Wandering Whistling Duck. Among the essential nutrients in poultry feed, protein plays a pivotal role. It supports the development of body tissues, improves intestinal health, enhances immunity, supports physiological functions, and boosts overall performance (Besky *et al*., 2015; Scanes and Dridi, 2022; He *et al*., 2021).

Research on Whistling Ducks has primarily focused on documenting their natural behaviours and ecological conditions in the wild nature. Studies have explored aspects such as diet (Rylander and Bolen, 1974), habitat preferences (Martin, 2017), the nutritional content of carcass (Petrie, 2005), moulting status (Petrie, 1985), and nesting behaviours (Ranade and Prakash, 2016). However, detailed studies on the intensive rearing of Whistling Ducks, particularly focusing on their digestive physiology and tract morphology, remain limited.

In poultry, extensive research has been conducted on the effects of feed protein levels. For instance, low-protein feed in chickens has been shown to reduce the height and width of duodenal villi (Incharoen *et al*., 2010; Mousa *et al*., 2023). Likewise, reducing crude protein levels effectively and positively influenced the composition of fecal microflora (Ladadio *et al*., 2012). Studies on ducks (Xie *et al*., 2017) and broilers (Kadam *et al*., 2007) indicate that low-protein diets may necessarily impair growth performance. Protein intake also influences hormonal responses associated with growth, which is important for weight gain (Swennen *et al*., 2011). However, excessive protein intake can lead to metabolic stress and does not always enhance body weight (Halle *et al*., 2010).

Optimal protein levels vary among duck species and development stages. For example, an 18% protein diet is optimal for Cherry Valley Ducks during the starter phase (Sritiawathai *et al*., 2013) and for Muscovy Ducks (Abdel-Hamid and Abdel-Fattah, 2020). In the grower phase, 15% protein is recommended for Pekin Ducks (Wu *et al*., 2024), while Sudan Ducks benefit from 18% protein during the early phase, 14% in the grower phase, and 17% in the layer phase (Awad *et al*., 2022). Waterfowl, including ducks, are categorized into three groups, herbivorous, mixed feeder, and insectivorous. Indeed, the wandering whistling duck is herbivorous and requires a relatively low protein level, typically ranging between 15-18% for adults (Brown, 1998). This protein requirement aligns with the grower phase needs of Muscovy Ducks, which also thrive on an 18% diet (Abdel-Hamid and Abdel-Fatah, 2020).

The aim of this current study was to investigate the effects of different dietary protein levels on the performance and digestive tract profile of the Wandering Whistling Ducks.

MATERIALS AND METHODS

Experimental Animals, Housing, and Management

A total of 108 Wandering Whistling Ducks, five months old with an average body weight of 543.77 ±38.58 g, were obtained from the "Belibis community" in Demak Regency, Central Java, Indonesia. Beside the age, the ducks were selected based on the body weight to ensure uniformity during the study. The study used 27 cages (1×1×0.7 m), each housing four unsexed Wandering Whistling Ducks. These ducks were fed twice daily (morning and evening) and provided *ad libitum* access to diet and drinking water.

The experimental protocol was reviewed and approved by the Animal Ethics Committee of the Faculty of Animal and Agricultural Sciences, Universitas Diponegoro with approval number 59-01/A-05/KEP-FPP.

Experimental Design and Dietary Treatment

The birds were randomly divided into three dietary treatment groups, each with nine replicates, resulting in a total of 27 experimental units. Each experimental unit consisted of four unsexed birds. The dietary treatments included T1: feed containing 12% protein, T2: feed with 15% protein, and T3: feed with 18% protein. The treatment diets were applied for two months. Prior to the dietary trial (which lasted for a month), an adaptation phase was implemented. In this phase, the birds were fed a commercial diet for

Table 1. Ingredients and Chemical Composition of the Treatment Diets

Feed ingredients (%)	Treatment groups		
	T1	T2	T3
Corn	64.0	62.0	59.0
Rice bran	27.0	21.0	15.0
Soybean meal	2.00	10.0	19.0
Meat bone meal	5.00	5.00	5.00
Dicalcium phosphate	0.30	0.30	0.30
Limestone	1.70	1.70	1.70
Nutrient content (%):			
Crude protein	12.5	15.2	18.3
Crude fat	6.70	5.94	5.15
Crude fiber	4.55	4.33	4.13
Metabolizable energy (kkal/kg)	2868	2858	2838
Lysin	0.53	0.72	0.94
Methionine	0.23	0.26	0.30
Phosphor	0.68	0.67	0.67
Calcium	1.17	1.19	1.21

T1: Wandering Whistling Ducks fed diets containing 12% crude protein, T2: 15%, and T3: 18%

two weeks, and for the next two weeks, the birds were fed a combination of the commercial diet and the treatment diet. The composition and nutritional contents of the treatment diets are detailed in Table 1.

The dietary protein levels applied in this current study were based on the protein requirements of grower-phase ducks, as outlined by the Indonesian National Standard, which specifies a minimum protein requirement of 14%. To establish the treatment levels, a mid-level value of 15% was chosen, with adjustments of 3% to represent higher (18%) and lower (12%) protein levels.

Samples Collection and Measurements

Feed and water intake were recorded daily, while weight gain was measured monthly. At the end of the dietary trial, two ducks, each replication, were slaughtered. Tissue samples (1×1 cm) from the duodenum, jejunum, and ileum were collected and fixed in a 10% phosphate-buffered formalin solution within 24 hours. The samples were subsequently embedded in paraffin and sectioned into slices 5 µm thick (Rashidi *et al.*, 2020). The sections were stained with Haematoxylin-Eosin for microscopic examination. Measurements were taken of villus height, crypt depth, and the villus height-to-crypt depth ratio for each intestinal segment.

Cecal digesta samples were collected and stored in sterile containers. Total bacterial populations were analyzed based on Sugiharto *et al.* (2018). MacConkey agar medium was used to observe coliform bacteria growth. Samples were incubated aerobically at 38 °C for 24 hours, with red colonies indicating coliform growth. Lactic acid bacteria (LAB) were cultured on De Man, Rogosa, and Sharpe (MRS) agar and incubated anaerobically at 38° C for 48 hours, where white colonies indicated LAB populations. The bacterial colony counts were expressed as log cfu/g.

The digestive organs were collected for pH and relative weight measurements. The pH of each digestive organ, from the proventriculus to the cloaca, was measured using a pH meter, according to Nkukwana (2015). Each organ was cleaned of surrounding fat, removed from the digesta, and weighed using a digital balance with a 100 g capacity and 0.01 accuracy. The small intestine and ceca lengths were determined using a tape measure. The relative weights and lengths of the digestive organs were calculated according to the method described by Incharoen (2013).

Data Analysis

Data were processed using SPSS software version 25. Data were analysed using one-way analysis of variance (ANOVA) at a 5% significance level. When significant differences were identified, means were further analysed using Duncan's multiple range test.

RESULTS AND DISCUSSION

The data on performance of intensively

reared Whistling Ducks are presented in Table 2. Feed consumption was similar between ducks fed diets containing 12% and 15% protein but was significantly lower ($P<0.05$) than those fed an 18% protein diet. The protein level in the feed did not affect water consumption nor the feed-to-water intake ratio. Weight gain during the study was significantly affected by dietary protein level ($P<0.05$), with the highest weight gain observed in ducks fed an 18% protein diet. Ducks fed diets containing 12% and 15% protein levels showed similar results.

The results for the length and weight of the digestive organs in Wandering Whistling Ducks are presented in Table 3. Our findings indicated that dietary protein levels did not affect the weight or length of the digestive tract. Additionally, the relative weight and length of the digestive tract were unaffected by variations in feed protein levels.

Table 4 presents the villus height, crypt depth, and villus-to-crypt depth ratio in the intestinal segments of Wandering Whistling Ducks. The protein level in the diet did not affect villus height in the duodenum, jejunum, or ileum. Similarly, crypt depth in the duodenum and jejunum was not affected by dietary protein levels. However, the crypt depth in the ileum was significantly greater ($P <0.05$) in the T3 group compared to T1 and T2. The villus-to-crypt ratio was consistent across all treatment groups.

The cecal bacterial population of Wandering Whistling Ducks can be seen in Table 5. Different feed protein levels did not affect ($P>0.05$) the population of LAB in the cecum. Coliform was not detected in the cecal samples, with no detectable values observed even at a 10^2 dilution. However, this result did not necessarily indicate the complete absence of coliform in the cecum but suggests that its presence was below the detection limit for the tested samples.

The pH values of the digestive tract are presented in Table 6. The results show that feed protein levels had no significant effect on the pH of most digestive organs in Wandering Whistling Ducks. However, a significant difference in pH was observed in the ventriculus, where diets containing 18% and 15% protein produced similar pH values that were significantly lower ($P <0.05$) than that of a 12% protein diet.

Typically, protein intake has a significant impact on satiety and energy balance. As protein levels in the diet increase, there is often a linear decrease in feed intake. This is likely due to the satiating effect of protein, which can modulate energy intake through increased feelings of fullness. The high thermic effect of protein also increases total energy expenditure, potentially contributing to reduced appetite. In this study, a dietary protein level of 18% was sufficient to meet the nutrient needs of Wandering Whistling Ducks during the grower phase without necessitating increased feed intake. Consequently, feed consumption at 18% protein is lower than that at 12% and 15% protein levels. Similar findings were reported by Mohanty *et al*. (2016) in Khaki Campbell Ducks during the grower phase, where feed consumption decreased at 16% and 18% protein compared to 14% protein. This condition implies that ducks may consume fewer feed when their protein needs are satisfied. In contrast, Cho *et al*. (2020) found that dietary protein levels did not affect feed consumption. Comparable results were also observed by Gunawan *et al*. (2024) on laying ducks and by Dapawole and Sudarma (2020), who reported no significant differences in feed consumption among ducks fed diets containing 12%, 15%, and 18% protein.

The dietary protein content in the diet (12-18%) did not affect water consumption in Wandering Whistling Ducks under intensive rearing conditions, indicating that protein level did not interfere water intake. Ecologically, Wandering Whistling Ducks, are waterfowl adapted to wetland environments (Birdlife International, 2024), which predisposes them to high water intake. In this study, the average daily water consumption of Wandering Whistling Ducks ranged from 622.57 to 761.05 mL per bird, which is higher than that of laying hens (150-182 mL per bird per day, as reported by Schneider *et al, 2016*) but comparable to other duck species, which consume approximately 796 mL per bird per day (Veltmann, 1981).

The highest cumulative weight gain in Wandering Whistling Ducks in this study was observed in those who consumed 18% protein feed. This result contrasts with the study conducted by Mohanty *et al*. (2016), who reported no significant effects of dietary protein levels (16%, 18%, and 22%) on weight gain in laying Khaki Campbell ducks. However, research on White Pekin

Table 2. Performance of Wandering Whistling Ducks Fed Diets Containing Different Protein Levels

Variable	Treatment groups			P value
	T1	T2	T3	
Feed intake (g/day/duck)	51.7^a	50.2^a	46.7^b	0.01
Water intake (ml/day/ duck)	761	694	622	0.34
Water and feed ratio	14.5	14.9	12.4	0.25
Cumulative weight gain (g/ duck)	43.2^b	42.4^b	68.7^a	0.05

^{ab}Superscripts in the same row indicate significant differences (P<0.05)
T1: Wandering Whistling Ducks fed diets containing 12% crude protein, T2: 15%, and T3: 18%

Table 3. Weight and Length of Digestive Organs in Wandering Whistling Ducks Fed Diets Containing Different Protein Levels

Variable	Treatment groups			P value
	T1	T2	T3	
Proventriculus to live weight ratio (%)	0.27	0.27	0.28	0.97
Ventriculus to live weight ratio (%)	2.09	2.54	2.37	0.06
Duodenum to live weight ratio (%)	0.25	0.31	0.27	0.07
Jejunum to live weight ratio (%)	0.76	0.64	0.71	0.32
Ileum to live weight ratio (%)	0.60	0.72	0.69	0.42
Caecum to live weight ratio (%)	0.16	0.15	0.09	0.08
Colon to live weight ratio (%)	0.14	0.16	0.16	0.49
Proventriculus index (mm/g)	0.98	1.06	0.98	0.06
Duodenum length index(mm/g)	2.30	2.72	2.72	0.07
Jejunum length index (mm/g)	5.63	5.74	6.31	0.13
Ileum length index (mm/g)	4.40	4.66	4.83	0.40
Secum length index (mm/g)	0.96	0.98	0.94	0.85
Colon length index (mm/g)	1.04	1.13	1.14	0.38

T1: Wandering Whistling Ducks fed diets containing 12% crude protein, T2: 15%, and T3: 18%

Table 4. Villus Height, Crypt Depth, and Cecal Lactic Acid Bacteria Population of Wandering Whistling Ducks Fed Diets Containing Different Protein Levels

Variable	Treatment groups			P value
	T1	T2	T3	
Villus height (µm)				
Duodenum	299	365	322	0.19
Jejunum	335	424	436	0.13
Ileum	309	338	322	0.84
Crypt depth (µm)				
Duodenum	102	126	103	0.08
Jejunum	89.1	93.7	86.9	0.79
Ileum	70.9^b	63.9^b	82.9^a	0.02
Villus/crypt ratio				
Duodenum	2.99	3.07	3.18	0.89
Jejunum	3.83	4.67	5.26	0.12
Ileum	4.26	5.27	3.88	0.06

^{ab}Superscripts in the same row indicate significant differences (P<0.05)
T1: Wandering Whistling Ducks fed diets containing 12% crude protein, T2: 15%, and T3: 18%

Table 5. Cecal Lactic Acid Bacteria and Coliform Populations in Wandering Whistling Ducks Fed Diets Containing Different Protein Levels

Variable	Treatment groups			P value
	T1	T2	T3	
LAB (log cfu/g)	4.63^b	4.51^b	5.77^a	0.05
Coliform (log cfu/g)	ND*	ND	ND	-

^{ab}Superscripts on the same row indicate significant differences (P<0.05)
*Not Detected (not detected at 10^2 dilution level), LAB: lactic acid bacteria, cfu: colony forming units

Ducks at the starter phase showed a significant increase in weight gain at a protein level of 19%, which was higher than that at 15% and 17% but similar to 21%, 23%, and 25% protein levels (Cho *et al*., 2020). Abdel-Hamid *et al*. (2020) also found that Muscovy Ducks given 18% protein had higher body weight gain than those given 14% and 22% protein. Wang *et al*. (2020) found that higher dietary protein levels resulted in greater final body weights in Pekin ducks, and Khattab (2020) observed that an 18% protein diet produced higher final body weights than 14% protein.

A dietary protein level of 18% has been shown to support optimal body weight in various duck species, and this finding extends to the Wandering Whistling Duck, a member of the Anatidae family. Brown (1986) reported that The Whistling ducks, which share similar ecological niches, require a dietary protein range of 15-18% to meet their growth needs. Adequate protein intake is critical for promoting body weight gain, as protein is one of the essential building blocks for poultry. Scanes and Dridi (2022) state that proteins are crucial for building and maintaining body structures, including muscles, feathers, and skin in poultry. Furthermore, He *et al*. (2021) highlighted that proteins play a multifaceted role in poultry physiology. They function not only as structural components but also as regulators of physiological processes, acting as signaling molecules, neurotransmitters, and metabolic modulators. These roles collectively contribute to optimal health, efficient growth, and enhanced productivity in poultry.

At present, there is no definitive literature that classifies Wandering Whistling Ducks that are five months old as being in the grower phase. However, observations of their reproductive organs at the beginning and end of the study (Figure 1) provide insight into their developmental stage. Initial examination of 5-month-old females revealed primordial follicles in the reproductive organs, indicating an undeveloped state. This finding aligns with studies by Cui *et al*. (2020) and Hu *et al*. (2021), which reported that primordial follicle growth begins shortly after hatching and accelerates by the sixth week in geese and ducks. These observations suggest that 5-month-old Wandering Whistling Ducks remain within the grower phase.

At 8 months of age, the reproductive organs showed the formation of white follicles, marking a transition in their development. According to Johnson (2000) and Etches (1996), primordial follicles progress into white follicles, signifying the conclusion of the grower phase and the onset of the pre-laying phase in poultry. In this stage, white follicles develop into yellow follicles, which are ready for ovulation as the birds enter the laying phase.

The digestive tract undergoes adaptations in response to increasing body weight. However, by the final grower phase, significant changes in digestive tract size. The results of this study indicated that the relative weight of the digestive tract in Wandering Whistling Ducks was not affected by dietary protein levels, likely because the birds had already reached the grower phase. This observation aligns with the results of Isnaeni *et al*. (2024), who reported similar outcomes in native chickens during their grower phase. In contrast, the introduction of dietary protein levels from the day-old chick (DOC) stage results in substantial differences in digestive tract development. For instance, Kurniawan *et al*. (2023) found that protein levels of 16%, 18%, and 20% significantly affected the relative weight of di-

Table 6. pH Values of the Digestive Tract of Wandering Whistling Ducks Fed Diets Containing Different Protein Levels

Variables	Treatment groups			P value
	T1	T2	T3	
Proventriculus	5.49	5.15	5.2	0.10
Gizzard	3.88[a]	3.54[b]	3.44[b]	0.02
Duodenum	5.53	5.53	5.72	0.52
Jejunum	5.70	5.70	5.96	0.16
Ileum	6.55	6.58	6.44	0.88
Cecum	6.41	6.31	6.25	0.55
Colon	6.58	6.59	6.49	0.84

[ab]Superscripts in the same row indicate significant differences (P<0.05)

T1: Wandering Whistling Ducks fed diets containing 12% crude protein, T2: 15%, and T3: 18%

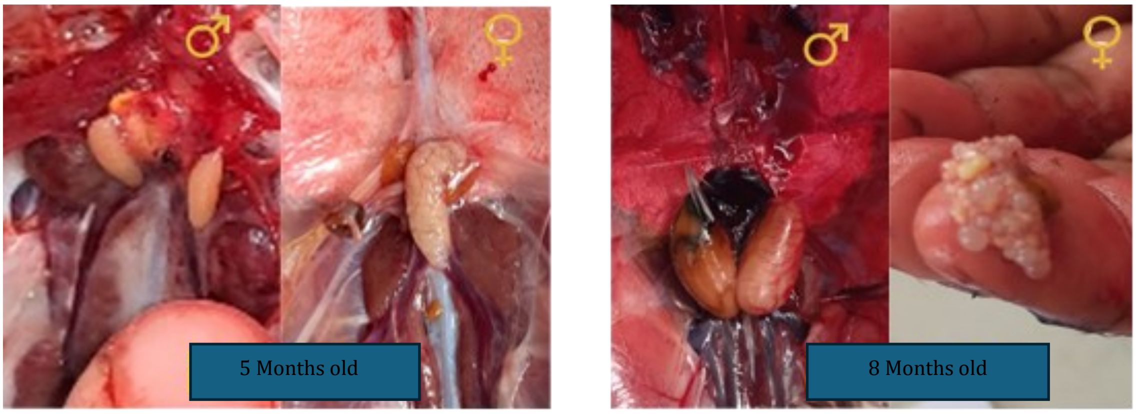

Figure 1. Reproductive Organs of Male and Female Wandering Whistling Ducks, Aged 5 and 8 Months Old

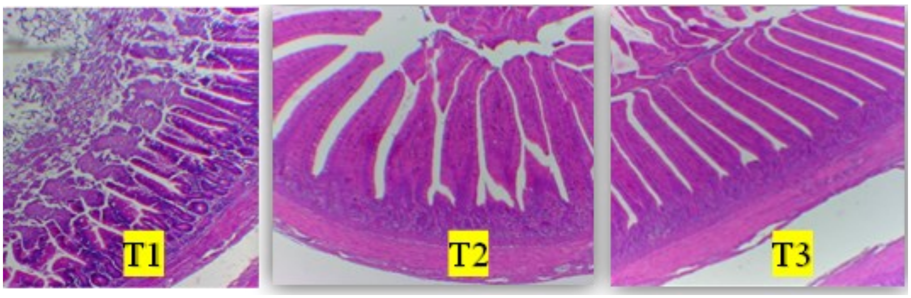

Figure 2. Ileal Histology of the Wandering Whistling Ducks. T1: Wandering Whistling Ducks fed diets containing 12% crude protein, T2: 15%, and T3: 18%

gestive organs in crossbred native chickens, suggesting that earlier nutritional interventions have a more pronounced impact on digestive tract development.

The relative length of the digestive tract in 5 -month-old Wandering Whistling Ducks was not influenced by the feed protein levels, perhaps because these birds had already surpassed the growth phase of their digestive tract development. In contrast, studies on 7-day-old broilers have shown significant differences in the relative length of the small intestine when fed diets with different protein levels (Lamot *et al*., 2019). During the early growth phase, protein plays a critical role in supporting the development and formation of tissues in the digestive tract. However, when provided during the grower phase, dietary protein is primarily allocated for reproductive development and the maturation of sexual organs.

The villus-to-crypt ratio and crypt depth in the ileum of Wandering Whistling Ducks were significantly influenced by dietary protein levels. Previous research indicates that the development of intestinal villi primarily occurs during the early stages of poultry life. For instance, studies in broilers (Uni *et al*., 1999) demonstrate that villi and crypt growth peaks between 6 and 10 days of age, with no significant differences observed by 42 days. Similarly, research by Sun *et al*. (2005) and Smirnov *et al*. (2005) reported that villus height and crypt depth remain relatively stable once broilers enter the growth period. The Wandering Whistling Ducks in this study were in the grower phase, characterized by a marked slowdown in growth. However, some crypt deepening was still observed, indicating ongoing intestinal adaptation. Sufficient dietary protein is essential to support optimal digestive tract development, including intestinal villi growth. Indeed, higher protein levels have been associated with enhanced villus development (Jamilah *et al*., 2014). The crypt depth observed at the 18% protein level showed the best results, indicating sufficient protein that supports balanced cell renewal, ultimately contributing to improve body weight gain. Crypts play a crucial role in supplying enterocytes for villus growth and increasing the rate of cellular regeneration (Geyra *et al*., 2001). This is evident in Figure 2, which illustrates differences in intestinal villi morphology in Wandering Whistling Ducks fed different protein level.

Histopathological analysis reveals that pathogenic bacteria are most likely responsible for intestinal damage in the ileum villi of ducks fed T1 (12% protein). In contrast, the intestinal villi of ducks fed T2 (15% protein) and T3 (18% protein) appeared normal, indicating that the nutrients consumed were adequate to support effective villus regeneration, potentially contributing to improve overall performance. Julendra *et al*. (2020) found that increase villus height is associated with improve nutrient absorption in the intestine, which can result in the increase of body weight gain and feed efficiency.

The Wandering Whistling Duck fed an 18% protein diet showed the highest concentration of LAB compared to other dietary treatments. Sufficient nutrients are likely to have promoted optimal intestinal villus growth across all segments of the digestive tract, and hence improving the conditions for beneficial bacterial colonization in the intestines as well as affecting the entire digestive tract. This is supported by Julendra *et al*. (2020), who revealed that robust villus growth helps prevent the colonization of pathogenic bacteria within the intestines. Specifically, an 18% protein diet appears to provide adequate conditions for LAB proliferation in the cecum. Supporting evidence from De Cesare *et al*. (2019) demonstrated that a 17.9% protein diet in broiler finishers increased LAB populations in the cecum and improved overall performance. The presence of protein levels in the diet influences LAB growth by influencing microbial competition for amino acids, potentially affecting bacterial growth and the production of toxic metabolites (Apalajati and Vianola, 2016). LAB has competitive exclusion (CE) properties, which can inhibit the growth of pathogenic bacteria. Lee *et al*. (2023) emphasized that CE products, often derived from the gut microbiota of healthy chickens, create a competitive environment that inhibits pathogen colonization. For instance, CE products have been shown to reduce *Salmonella* colonization by multiple logs, demonstrating their efficacy in pathogen control.

The pH of the gizzard of the Wandering Whistling Duck is influenced by dietary protein levels, with the T1 treatment (12% protein) showing significantly higher pH than the T2 (15%) and T3 (18%) treatments. The 12% protein diet, which contains a higher proportion of corn, results in a coarser feed texture, leading to more mechanical grinding in the gizzard. In the gizzard feed is triturated with the assistance of grit and the inner wall surface of the ventricle. Svihus (2014) explained that in the gizzard, feed is mechanically broken down due to the absence of chewing in the mouth, with the presence of myofilament muscles and a chitin-like lining resembling sandpaper, which aid in the grinding process. Higher feed intake in the T1 treatments leads to a greater volume of feed entering the gizzard, thus contributing to an increase in the pH level of the gizzard. This observation aligns with Svihus (2014), who suggested that feed generally has a neutral pH, and increased feed consumption can elevate the pH in the gizzard. The pH values observed in this study are consistent with those reported in other poultry species. The pH levels of the digestive tract in broilers and Venda chickens, in the following order: crop (4.8, 4.63), proventriculus (4.38, 4.58), ventriculus (3.22, 3.79), duodenum (5.89, 5.86), jejunum (6.20, 5.44), and ileum (6.64, 5.78) (Mabelebele *et al*., 2017).

CONCLUSION

The Wandering Whistling Duck can be successfully maintained in intensive systems, such as closed cages, when fed diets containing 12% to 18% protein, without negatively affecting water consumption or the size of the digestive tract. Additionally, a diet with 18% protein appears to be optimal to improve body weight gain in these birds.

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