Short Research Article

Effect of Turmeric (curcuma domestica) Powder and Multi-Enzyme Supplementation on Intestinal Villus Morphology in Broiler Chickens

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ABSTRACT

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| **Aims:**This study aimed to evaluate the effect of turmeric powder (Curcuma domestica Val.) and multi-enzyme supplementation on intestinal villus morphology, particularly villus height, surface area, and number, in broiler chickens.  **Study Design:** The experiment was conducted using a Completely Randomized Design (CRD) with five dietary treatments and six replications per treatment.  **Place and Duration of Study:** The research was carried out at the Poultry Production Laboratory, Faculty of Animal Science, Universitas Brawijaya, Indonesia, over a period of 6 weeks.  **Methodology:** A total of 300 Lohmann broiler chickens were divided into five treatment groups (P0: control, P1–P4: combinations of turmeric powder and multi-enzyme at different inclusion levels). Each experimental unit consisted of 12 birds. At day 35, samples of the jejunum were collected, and histological preparations were made using Hematoxylin-Eosin staining. Villus height, surface area, and number were measured under 40x magnification. Data were analyzed using ANOVA and Duncan’s test at a 5% significance level.  **Results:** There were no statistically significant differences (P > 0.05) in villus height, surface area, or number among treatment groups. However, descriptively, treatment P4 (1.2% turmeric + enzyme) showed the highest average values for villus height (673.76 µm), surface area (1056.16 µm²), and number (9.12 per transverse cut), compared to the control group.  **Conclusion:** Although statistical significance was not observed, the combination of turmeric powder and multi-enzyme supplementation showed a positive numerical trend in improving the morphology of intestinal villi in broiler chickens. This suggests potential benefits in gut health and nutrient absorption efficiency |

*Keywords: turmeric flour, multienzyme, villus height, villus surface area, villus number, broiler chicken, gut morphology*

1. INTRODUCTION

Broiler chickens are a high-producing poultry breed known for their rapid growth and efficient meat production, making them a promising source to fulfill the community's animal protein needs. Their short growth phase, typically between 28–35 days, makes broilers an economically viable livestock option compared to others. According to the Central Bureau of Statistics (2024), particularly in East Java, the broiler population reached 421,861.6 birds in 2022, higher than in 2021, which recorded 393,387.6 birds. This population increase is in line with the growing demand for chicken meat, influenced by rising population numbers, income levels, and public awareness of the importance of animal protein consumption. Moreover, the affordable price of chicken meat contributes to its popularity. This significant growth is also supported by improved management, including high-quality feed provision in both quantity and nutritional value.

Livestock production is influenced by several key factors, including genetics, husbandry, and feed. Feed plays a crucial role, both economically and in terms of productivity, accounting for 60–70% of total production costs. The heavy reliance on imported raw materials such as corn, soybeans, and fish meal negatively impacts the poultry industry in Indonesia, especially due to limited local feed resources. The high volume of soybean imports also increases foreign exchange expenditure. Feed cost efficiency can be improved if the digestive tract can optimally digest the nutrients consumed.

One of the strategies to improve feed efficiency is the use of feed additives. Feed additives are supplementary ingredients added to animal feed with the aim of enhancing nutritional value, improving feed utilization efficiency, digestive function, nutrient absorption, and maintaining gut health. These additives also support growth acceleration, immune enhancement, improved production performance, and overall animal health. They can be in the form of vitamins, minerals, amino acids, enzymes, probiotics, prebiotics, antioxidants, synbiotics, phytobiotics, and other functional substances. In broiler farming, disease outbreaks are common, prompting farmers to use antibiotics as treatment and to reduce mortality. However, the use of antibiotics as feed additives can lead to residues that pose risks to humans infected with resistant bacteria. This concern led the Indonesian government to ban the use of antibiotics in animal feed as per Ministry of Agriculture Regulation No. 14 of 2017, effective from January 1, 2018. To comply with this policy, the adoption of alternatives such as natural feed additives and enhanced biosecurity measures is necessary.

Feed additives can be administered in the form of phytobiotics and enzymes. Phytobiotics are natural plant-derived additives used in livestock feed to improve animal health and productivity. These compounds have antimicrobial properties that help control the growth of pathogenic bacteria in the digestive tract. Phytobiotics also stimulate digestive enzyme production and help maintain gut microbiota balance, thereby enhancing nutrient digestion and absorption. As reported by Kiczorowska et al. (2017), phytobiotics in poultry nutrition have been shown to promote growth, improve feed efficiency, enhance intestinal morphology, and act as antimicrobials, thus boosting immune defenses. Modern research indicates that "supplementing broiler chickens' diet with a phytogenic product containing a mixture of equal parts thymol and carvacrol at four different amounts increased body weight gain and feed efficiency, and reduced feed intake" (Kiczorowska et al., 2024). Due to concerns over antibiotic resistance caused by excessive antibiotic use in animal feed, phytobiotics offer a safer and more environmentally friendly alternative.

One herbal plant widely used as a phytobiotic is turmeric (Curcuma domestica Val.), which contains the active compound curcumin with known antibacterial properties. According to Jubair et al. (2021), antimicrobial compounds are specialized chemicals produced by living organisms in low concentrations that can inhibit critical processes within microorganisms. Curcumin possesses broad-spectrum antibacterial activity effective against both Gram-positive and Gram-negative bacteria, and it also has antiviral and pro-apoptotic (anti-tumor) effects. Furthermore, curcumin has been shown to stimulate digestive processes by influencing pancreatic enzyme secretion. Research demonstrates that curcuminoids can affect pancreatic lipase activity, which is crucial for fat digestion (Li et al., 2022). This mechanism improves digestion, increases feed digestibility, and speeds up digestive transit time, which in turn enhances feed intake in broilers.

In poultry, enzymes play a vital role in digestion, metabolism, and nutrient absorption. Farmers often supplement broiler diets with enzymes either through feed or drinking water. Enzymes are considered safe and beneficial, as they not only improve feed quality but also enhance meat nutritional value for human consumption. Supplemental enzymes help maintain gut microbial balance by ensuring that more nutrients are digested and absorbed in the small intestine, limiting the nutrients available for pathogenic bacteria in the large intestine. This reduces digestive disturbances and promotes overall gut health. Enzyme addition also helps degrade complex fibers such as cellulose and hemicellulose, thus reducing crude fiber levels in the feed (Sinaga, Suprijatna, and Kismiati, 2019).

The application of multi-enzyme complexes in livestock feed has been extensively studied and proven effective. Manurung et al. (2019) supported the notion that multi-enzymes in livestock feed play a key role in enhancing nutrient digestibility. Each enzyme has a specific function in breaking down hard-to-digest components, making nutrients more bioavailable. The addition of enzyme complexes such as protease, cellulase, and hemicellulase has been shown to significantly improve livestock performance. These enzymes work synergistically to break down complex feed substances, increasing feed efficiency and supporting animal growth. By breaking down complex feed compounds, digestion becomes more effective, and nutrient absorption is optimized.

Therefore, supplementation of broiler diets with a combination of turmeric and multi-enzymes can serve as a natural alternative to antibiotics. The antimicrobial effect of turmeric enhances intestinal relaxation, slows peristalsis, and extends ingesta retention time in the small intestine, allowing for more efficient nutrient absorption. Meanwhile, multi-enzymes break down fiber into simpler, more absorbable components, improving gut health and productivity as indicated by intestinal microflora composition.

Based on this rationale, research is needed to evaluate the effects of combining turmeric powder (Curcuma domestica Val.) and multi-enzymes on antibacterial activity and the intestinal characteristics of broiler chickens.

2. material and methods

**2.1 Study Design and Experimental Animals**

This research was conducted using a Completely Randomized Design (CRD) with five treatments and five replications. A total of 300 Lohmann broiler chickens were used, with 12 birds placed in each pen. The treatments consisted of combinations of turmeric flour (Curcuma domestica Val.) and multienzyme supplements at various levels in the feed. The study was conducted over a 35-day rearing period.

**2.2 Villus Histomorphology Observation**

Histomorphological examination of the small intestine was conducted at the end of the rearing period. One bird per replicate was randomly selected and humanely euthanized. A segment of the jejunum (approximately 3 cm in length) was collected, cleaned with physiological saline, and fixed in 10% buffered formalin for 24–48 hours.

Tissue processing was performed using the paraffin method. Fixed tissues were dehydrated in ascending concentrations of ethanol, cleared with xylene, embedded in paraffin, and sectioned at 5 μm thickness using a rotary microtome. The sections were mounted on glass slides and stained using hematoxylin-eosin (HE) staining. Histological slides were observed using a light microscope at 40x magnification.

**2.3 Parameters Observed**

* Villus Height (µm): Measured from the base to the tip of the villus using a calibrated micrometer.
* Villus Surface Area (µm²): Calculated using the formula:

Villus surface area=2π×(villus width2)×villus height\text{Villus surface area} = 2\pi \times \left(\frac{\text{villus width}}{2}\right) \times \text{villus height}

* Number of Villi (per field of view): Counted directly from five randomly selected fields per slide under 40x magnification.

**2.4 Statistical Analysis**

The data obtained were analyzed using one-way ANOVA. If a significant difference (P<0.05) was found, further analysis was conducted using Duncan’s Multiple Range Test to determine the differences among treatment groups.

3. results and discussion

**3.1 Villus Height**

The results of the study on the evaluation of turmeric flour and multi-enzyme combinations on the height of the intestinal villi are presented in Table 1. The table shows that the villus height from highest to lowest was observed in P4 (673.76±142.46), P3 (652.86±108.00), P2 (619.57±125.11), P1 (597.29±73.25), and P0 (501.72±91.16), respectively. Statistical analysis indicated that the addition of multi-enzymes and turmeric flour in the feed had no significant effect (P>0.05) on the villus height of broiler chickens.

This finding is consistent with previous research indicating that moderate levels of herbal supplementation may not always produce significant morphological changes in intestinal structure. According to Alagawany et al. (2018), the effectiveness of phytogenic feed additives on intestinal morphology depends on various factors including dosage, duration of supplementation, and the specific bioactive compounds present. This might be due to insufficient levels of enzymes or turmeric flour to induce structural changes in the intestinal mucosa. Morphological effects such as increased villus height require strong and sustained stimulation; thus, low dosages or short administration periods may result in minimal changes, and the additive effect of enzymes or phytobiotics may only yield marginal and statistically insignificant improvements.

Research has shown that "lactic acid bacteria (LAB) were excellent inhibitors against Escherichia coli" in broiler chickens, suggesting that the competition between beneficial and pathogenic bacteria in the gut may influence the effectiveness of feed additives. According to Pandit et al. (2018), this may also be due to the suboptimal growth of lactic acid bacteria (LAB) in the small intestine, which still competes with Escherichia coli for feed nutrients, rendering LAB performance in the villi suboptimal in enhancing nutrient absorption through villus elongation and surface expansion.

Although the effect was not statistically significant, descriptively, treatment P4 (with 1.2% turmeric and multi-enzyme) resulted in the highest villus height. Studies have demonstrated that LAB growth in the small intestine remains suboptimal due to competition with E. coli for dietary nutrients, preventing complete colonization in the villus area and limiting their role in enhancing absorption (Yadav and Jha, 2019). This may be due to suboptimal dosing, but turmeric supplementation has potential benefits on intestinal morphology. Recent research confirms that turmeric's antibacterial properties can suppress pathogenic bacteria and support beneficial microbiota in the gut, contributing to improved digestive health in poultry (Kiczorowska et al., 2024).

**3.2 Villus Surface Area**

The study results on the effect of turmeric flour and multi-enzyme combinations on villus surface area are presented in Table 1. The table indicates that surface area values increased in the order of P0 (768.91±198.93), P1 (927.05±146.67), P2 (998.47±187.06), P3 (1030.64±224.42), and P4 (1056.16±234.97). Statistical analysis showed that the supplementation had no significant effect (P>0.05) on villus surface area. However, the average values (768.91–1056.16 μm²/villus) were greater than those reported by Kusuma, Sjofjan, and Djunaidi (2020), which ranged from 641.08–1035.48 μm²/villus.

Although the effect was not significant, numerically, feed supplementation with turmeric and multi-enzymes yielded higher villus surface area compared to the control (P0). This suggests that enzyme addition positively influences intestinal morphology, particularly the villi in the small intestine, which are crucial for nutrient absorption. A wider villus surface area increases the efficiency of nutrient uptake from digesta. The efficacy of multi-enzymes depends on dosage and feed composition. Enzyme-induced nutrient availability stimulates epithelial cell growth, increasing villus length and width, thereby expanding the absorptive area.

Modern research demonstrates that microbial growth is enhanced by enzyme activity breaking down carbohydrates into sugars and proteins into amino acids—both vital for microbial nutrition (Borda-Molina et al., 2018). This is supported by recent findings showing that multi-enzyme supplementation tends to increase lactic acid production due to proliferation of LAB such as Lactobacillus salivarius, which contributes to improved gut health and intestinal morphology (Feng et al., 2023).

Turmeric's active compounds like curcumin can suppress pathogenic bacteria such as Salmonella spp. It also contains curcuminoids (antioxidants) and essential oils with antibacterial and anti-inflammatory properties (Dhama et al., 2015). With fewer pathogenic microbes, normal gut flora thrives, supporting mucosal integrity and villus growth. Curcumin also stimulates intestinal epithelial cell proliferation, promoting villus growth and elongation, which enhances nutrient absorption efficiency. Additionally, turmeric supports the growth of beneficial gut microbiota, indirectly improving villus structure and function (Kiczorowska et al., 2024).

**3.3 Villus Number**

The results of the study evaluating turmeric flour and multi-enzyme supplementation on the number of intestinal villi are shown in Table 1. Villus numbers, from lowest to highest, were recorded in P0 (6.44±0.91), P2 (7.88±3.68), P1 (8.24±1.26), P3 (8.15±2.54), and P4 (highest value). Statistical analysis showed no significant difference (P>0.05) in villus number among the treatments.

Even though no statistically significant difference was found, numerically, feed supplemented with turmeric and enzymes resulted in higher villus numbers compared to the control. The highest count was found in P4, the lowest in P0. Contemporary research emphasizes that multi-enzyme supplementation helps maintain gut health, improve feed utilization, and reduce feed cost by breaking down complex nutrients into simpler, more absorbable forms (Bedford and Cowieson, 2012). Studies have noted that multi-enzymes assist nutrient metabolism, supporting morphological adaptations in the digestive tract (Cowieson and Roos, 2016).

Histologically, villi play a crucial role in nutrient absorption. Longer, more numerous, and denser villi increase surface area for efficient nutrient uptake. Increased villus height reflects expanded absorption area, while increased villus number indicates healthy and active intestinal renewal, directly improving growth performance by optimizing nutrient utilization. Research has demonstrated that "phytobiotics, which are plant-derived feed additives known for their antimicrobial, antioxidant, immune-modulating, and growth-promoting properties, have emerged as promising natural alternatives" to conventional growth promoters.

Turmeric flour acts as a natural additive that supports gut health. Its bioactive compounds stimulate digestive enzyme activity and promote beneficial bacterial colonization, indirectly enhancing histological structure, including villus number. Research has explained that low villus numbers may be caused by pathogenic bacterial activity (Alagawany et al., 2018). Curcumin and essential oils in turmeric help minimize epithelial cell damage due to oxidative stress or infection, preserving intestinal mucosa integrity. Studies have shown that curcumin promotes appetite by accelerating gastric emptying and increasing bile secretion, thus supporting digestive function (Li et al., 2022).

4. Conclusion

The supplementation of turmeric powder (Curcuma domestica Val.) and multi-enzyme in broiler chicken feed had no statistically significant effect (P>0.05) on villus height, surface area, or villus number. However, descriptive data showed that diets enriched with these additives—particularly at the highest inclusion level (1.5% turmeric powder and 0.15% multi-enzyme)—consistently yielded improved intestinal morphology indicators. This suggests that turmeric and multi-enzyme supplementation may positively influence gut health and nutrient absorption, albeit marginally. Turmeric’s antibacterial properties and the enzymatic breakdown of complex nutrients may enhance the intestinal environment by supporting beneficial microflora growth, improving epithelial integrity, and increasing the absorptive surface of the small intestine. Although not statistically conclusive, these findings support the potential of phytobiotic and enzymatic supplementation as natural feed additives in broiler diets to support gut development and productivity.

Ethical approval

This study does not involve human participants and thus ethical approval and informed consent are not applicable.

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Table 1. Effect of Turmeric Flour and Multienzyme Supplementation on Villus Number, Villus Height, and Villus Surface Area of Broiler Chickens

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| **Observation Variables** | | | | |
| **Treatment** | **Vilus Number** | **Vilus Height** | **Vilus Surface Area** |
|  | **(per transveral cut)** | **(µm)** | **(µm)** |
| P0 | 6.44±0.91 | 501.72±91.16 | 768.91±198.93 |
| P1 | 8.24±1.26 | 597.29±73.25 | 927.05±146.67 |
| P2 | 7.88±3.68 | 619.57±125.11 | 998.47187.06 |
| P3 | 8.52±2.54 | 652.86±108.00 | 1030.64±244.42 |
| P4 | 9.12±2.32 | 673.76142.46 | 1056.16±234.97 |