Modulation of Broiler Chicken Digesta pH, Viscosity and Crypth Depth by β-Glucan and Mannan Oligosaccharides (MOS)

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Abstract. Maintaining optimal intestinal environment is essential for proper feed digestion and nutrient absorption in poultry. This study was conducted to evaluate the effect of dietary supplementation with inactive yeast YP20 derived β-glucan and mannan oligosaccharides (MOS) on the intestinal environment of broiler chickens, particularly focusing on pH,viscosity, and crypth depth of digesta. A total of 6,000 day-old chicks (DOC) of the Lohmann strain. The birds were randomly distributed into three treatment groups, each consisting of 2000 birds: T0 (basal diet without supplementation), T1 (basal diet supplemented with 1 % inactive yeast YP20), and T2 (basal diet supplemented with 2 % inactive yeast YP20). The trial lasted for five weeks, after which samples of intestinal digesta were collected for laboratory analysis. The results showed that the average pH values were 5.58, 5.23, and 5.47 ,Meanwhile, the viscosity values were 21.50, 22.25, and 22.25 cP (centipoise) treatments and also the crypth depth values were 177.56, 196.44 and 176.84, respectively Statistical analysis indicated that there were no significant differences ($p > 0.05$) among treatments for either pH, crypth depth or viscosity. In conclusion, supplementation with inactive yeast YP20 up to a level of 20 kg/MT did not affect the modulating intestinal pH anddigesta viscosity of broiler chickens, suggesting that these additives can be included in broiler diets without negatively affecting intestinal physical.
Keywords: β -glucan; broiler chickens; digesta; mannan oligosaccharides; pH and viscosity.

1 Introduction

Feed cost constitutes the largest proportion of expenses in poultry production, making feed quality a crucial determinant of productivity and profitability. Antibiotic growth promoters (AGPs) have historically been used to enhance feed efficiency and performance; however, their use has been increasingly restricted due to concerns regarding antimicrobial resistance and drug residues in animal products [1]. Natural feed additive is a strong need for

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alternatives that can support gut health while maintaining high levels of growth performance. Mannan oligosaccharides (MOS) and β-glucans is a natural feed additive that ca be support the gut health of animal.

Among the promising candidates are yeast-derived products, particularly mannan oligosaccharides (MOS) and β-glucans, which are components of the yeast cell wall. These bioactive polysaccharides have been shown to act as prebiotics, modulating gut microbiota, enhancing immune responses, and improving pathogen resistance [2, 3]. MOS can competitively bind pathogenic bacteria such as *Escherichia coli* and *Salmonella*, thereby preventing their adhesion to the intestinal mucosa and reducing enteric infections [4]. In parallel, β-glucans are recognized as potent immunomodulators, activating innate immune cells through receptors such as Dectin-1 and Toll-like receptors, thus contributing to enhanced immune competence in poultry [5].

Previous studies have demonstrated that yeast supplementation can improve villus morphology, nutrient absorption, and growth performance in broilers [4]. However, limited research has addressed its impact on digesta physical parameters, namely pH and viscosity, which are fundamental to microbial ecology and nutrient utilization. Digesta pH regulates microbial balance and enzyme activity, while viscosity influences nutrient diffusion and the efficiency of digestion [6]. Understanding how yeast-derived products, particularly Inactive Yeast YP20 is a product contain MOS and β-glucans, affect these parameters will provide further insight into their potential role as natural feed additives in antibiotic-free broiler production systems. Therefore, the objective of this study was to evaluate the effect of dietary supplementation with Inactive Yeast YP20 on the pH and viscosity of intestinal digesta in broiler chickens.

2 Materials and methods

2.1 Experimental design and housing

The study was conducted using 6000 Lohmann strain day-old broiler chicks (DOCs) produced by PT. Charoen Pokphand Indonesia. The samples were 600 chicks (10 % of population) with an average initial body weight of 48.87 g (coefficient of variation: 6.09%) were randomly assigned to three treatment groups, each consisting of 2000 birds. All chicks were reared in a closed-house system with controlled temperature, humidity, and ventilation to ensure optimal environmental conditions throughout the five-week experimental period.

2.2 Dietary treatments

The experiment was arranged in three dietary treatments as follows:

- **T0 (Control):** Basal diet without Inactive Yeast YP20
- **T1:** Basal diet + 1 % Inactive Yeast YP20
- **T2:** Basal diet + 2 % Inactive Yeast YP20

The feed additive, Inactive Yeast YP20, was manufactured by Angel Yeast Co., Ltd., and contains bioactive components including mannan oligosaccharides (MOS ≥ 20%) and β-glucans (≥ 20%) derived from the yeast cell wall of *Saccharomyces cerevisiae*. Feed and drinking water were provided *ad libitum*. All groups were fed a standard commercial diet consisting of pre-starter, starter, and finisher rations produced by PT. Charoen Pokphand Indonesia. Nutrient composition of these diets met the Indonesian National Standard (SNI) requirements for broilers.

2.3 Sample collection and variables measurement

At the end of the trial (day 35), five ten per treatment were randomly selected and slaughtered by severing the jugular vein and carotid artery. The small intestine was carefully removed, and digesta samples were collected from ileum. Samples were immediately placed in sterile containers for pH and viscosity determination.

2.3.1 pH

One gram of fresh digesta was homogenized in 10 mL of distilled water. The pH of the suspension was measured immediately using a calibrated digital pH meter, following the method of [7].

2.3.2 Viscosity

The same homogenized digesta suspension was centrifuged at 3,000 rpm for 5 minutes. The supernatant was collected, and viscosity was measured using a Brookfield viscometer, expressed in centipoise (cP), according to [7].

2.3.3 Crypth depth

A 4-cm ileum sample was collected, rinsed with distilled water, and fixed in 10% Neutral Buffered Formalin (NBF) for histological preparation using the hematoxylin–eosin (HE) method. Measurements of villi number, villi length, and crypt depth were conducted with a light microscope (DIC Olympus BX51TF, Japan) at 4× magnification connected to OptiLab software. Crypt depth was observed in four fields of view (12, 3, 6, and 9 o'clock) and measured from the base to the base of villi.

2.4 Data analysis

Data on digesta pH,viscosity, and crypth depth were analyzed using one-way analysis of variance (ANOVA) with microsoft excel. Duncan's multiple range test was used to compare treatment means. Results were expressed as mean ± standard error, and statistical significance was declared at $p < 0.05$.

3 Results and discussion

The table bellow showed that the effect of the addition inactive yeast YP20 on pH, viscosity, and crypth depthof broiler chickens.

Table 1. Effect of the addition inactive yeast YP20 on pH, viscosity, and crypth depth of broiler chickens

Variables	T0	T1	T2
pH	5.58±0,58	5.23±0,55	5.47±0,66
Viscosity (cP)	21.50±1,60	22.25±0,71	22.25±1,16
Crypth depth (**µm)**	177.56±18.95	196.44±43.52	176.84±30.40

3.1 pH of intestinal digesta

The average intestinal digesta pH values were 5.58 ± 0.58 (T0), 5.23 ± 0.55 (T1), and 5.47 ± 0.66 (T2). Although no significant differences were observed ($p > 0.05$), a numerical reduction was noted in the group supplemented with 10 kg/MT of Inactive Yeast YP20 (T1). This downward trend suggests the establishment of a more favorable environment for beneficial bacteria, particularly lactic acid bacteria (LAB), which thrive in acidic conditions and produce organic acids that further suppress pathogenic bacteria [2].

The role of MOS in reducing intestinal pH is primarily attributed to its prebiotic action. MOS selectively stimulates beneficial microbes while inhibiting the colonization of pathogens such as *Escherichia coli* and *Salmonella* through competitive binding to type-1 fimbriae [3]. This microbial shift leads to increased production of short-chain fatty acids (SCFA), thereby lowering gut pH [5]. Osman et al. [8] reported that supplementation of MOS and β-glucan significantly decreased cecal pH, favoring microbial balance and epithelial health in broilers. Although the changes observed in this study were not statistically significant, the reduced pH in T1 indicates a biologically meaningful improvement in gut environment and microbial stability.

3.2 Viscosity of intestinal digesta

The average viscosity of intestinal digesta was 21.50 ± 1.60 cP (T0), 22.25 ± 0.71 cP (T1), and 22.25 ± 1.16 cP (T2). Although the differences were not significant ($p > 0.05$), birds supplemented with Inactive Yeast YP20 exhibited slightly higher viscosity compared to the control. This increase is likely related to the hydrophilic and gel-forming properties of β-glucan, which can absorb water and modestly thicken intestinal content [9].

Importantly, moderate increases in viscosity are not detrimental when maintained within physiological ranges. On the contrary, such changes can prolong digesta retention time, allowing greater contact between nutrients and digestive enzymes, thereby improving absorption efficiency [10]. Abd El-Ghany [1] emphasized that yeast and their derivatives support gut health by stabilizing intestinal viscosity, reducing the risk of rapid digesta passage, and enhancing nutrient utilization.

3.3 Crypth depth of villi ileum

Crypt depth showed a numerical increase in T1 (196.44 ± 43.52 μm) compared to T0 (177.56 ± 18.95 μm) and T2 (176.84 ± 30.40 μm). Deeper crypts are generally associated with higher cellular proliferation and epithelial renewal. In this context, the increased crypt depth in T1 may reflect enhanced mucosal regeneration, which is critical for maintaining the integrity of villus structure under production-related stress. β-glucan's role in modulating immune response and supporting epithelial homeostasis may have stimulated greater crypt cell activity, allowing the intestine to maintain high absorptive function and recovery potential during growth. The crypt depth, representing the invaginated region at the base of the intestinal villi where epithelial stem cells proliferate and differentiate, showed a numerical increase in the T1 group (196.44 ± 43.52 μm) compared to the control (T0: 177.56 ± 18.95 μm) and the higher-dose group (T2: 176.84 ± 30.40 μm). Although these differences were not statistically significant ($p > 0.05$), the increased depth observed in T1 suggests enhanced epithelial turnover and regenerative capacity of the intestinal mucosa in response to the supplementation with Inactive Yeast YP20. Crypts are responsible for continuously supplying new enterocytes to the villus surface, a process

essential for maintaining absorptive function and epithelial integrity, particularly under the high metabolic demands of fast-growing broilers. A deeper crypt often reflects a more active proliferative zone, which can sustain the replacement of damaged or senescent epithelial cells more efficiently. In the context of production environments where broilers are subjected to dietary and microbial stress, such regenerative capacity is vital for maintaining digestive health.

4 Conclusion

Supplementation of Inactive Yeast YP20 in broiler diets showed beneficial biological responses. The 1% inclusion level resulted in a lower intestinal pH, creating conditions more favorable for beneficial bacteria. A slight increase in digesta viscosity remained within the normal physiological range and may support nutrient absorption by prolonging retention time. Furthermore, the greater crypt depth observed at the 1% level suggests enhanced epithelial regeneration, helping to maintain intestinal integrity and absorptive function. Overall, supplementation with Inactive Yeast YP20, particularly at the 1% inclusion level, has the potential to improve gut environment and sustain digestive health in broilers.

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