Optimizing growth: effects of pellet binder viscosity and protease-enriched drinking water on the performance of *IPB-D1* chickens

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Abstract. Pellet quality is a key factor influencing poultry growth performance. The use of carboxymethyl cellulose (CMC) as a pellet binder and protease enzyme supplementation via drinking water may improve nutrient availability and digestive efficiency. This study evaluated the effects of carboxymethyl cellulose (CMC) with varying viscosities and protease enzyme supplementation via drinking water on growth performance in IPB-D1 chicks (n = 250) with five dietary treatments in a Completely Randomized Design (5 replicates of 10 chicks each). Treatment included: a control diet (C0P0), a diet containing 0.5% CMC with a viscosity of 1000–2500 cps (C1P0), the same CMC level and viscosity with 10 mg/L protease enzyme in drinking water (C1P1), a diet containing 0.5% CMC with a viscosity of 2500–4000 cps (C2P0), and the same CMC level and viscosity with 10 mg/L protease enzyme in drinking water (C2P1). Growth performance parameters evaluated included feed intake, water intake, body weight gain, feed conversion ratio (FCR), and mortality. No significant differences ($P>0.05$) were found across treatments. However, descriptively, the combination of high-viscosity CMC and protease enzyme showed a tendency to improve growth efficiency. This suggests a potential synergistic effect worth further exploration in IPB-D1 chickens.

1 Introduction

The poultry industry plays a vital role in meeting the increasing demand for animal protein in Indonesia. Rising consumer demand has driven innovation in poultry production systems aimed at improving productivity. Among these innovations is the development of native or local chicken breeds, which are widely appreciated for their unique meat flavor.

Local breeds also exhibit greater disease resistance, adaptability to local feed resources, and moderate to fast growth rates. One such breed, the IPB-D1 chicken, was developed through a crossbreeding program involving F1 PS males (Pelung × Sentul) and F1 KM

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females (Kampung × Parent Stock Cobb). This genetic combination is intended to enhance desirable traits such as meat quality, growth performance, and disease resistance in local chickens [1].

Feed quality is a critical determinant of growth performance and overall health in poultry. Among various feed processing methods, pelleting is commonly employed to improve feed handling, optimize nutrient balance, and reduce feed waste and production costs [2]. Pellet quality can be further enhanced by incorporating feed binders, which improve pellet durability, minimize feed disintegration during transportation, and contribute to feed intake efficiency [3]. Common binders used in poultry feeds include calcium lignosulfonate (Ca-LS), bentonite, zeolite, calcium carbonate ($CaCO_3$), magnesium oxide (MgO), and carboxymethyl cellulose (CMC) [4,5].

The choice of binder depends on the target species, feed composition, and desired pellet characteristics. CMC, in particular, is a cellulose-derived binder with water-soluble fiber properties, known for its ability to modulate viscosity, which can influence nutrient digestion and absorption in poultry [6]. Optimal growth in IPB-D1 chickens depends on the efficient digestion and absorption of nutrients [7]. As monogastric animals, chickens rely on supplemental enzymes, such as proteases, to enhance protein breakdown and nutrient bioavailability.

Supplementing drinking water with protease enzymes may provide a practical approach to improve digestive efficiency, given the central role of water in metabolic and digestive processes. The typical pH range of poultry drinking water (6.5-7.5) supports protease stability and activity, allowing the enzyme to remain functional until it reaches the gastrointestinal tract. Although enzyme supplementation is more commonly applied via feed, limited research has explored its administration through drinking water. This study was therefore designed to evaluate the effects of protease enzyme supplementation via drinking water, in combination with pelleted diets containing CMC binders with different viscosities, on the growth performance of IPB-D1 chickens.

2 Materials and methods

This study was designed to evaluate the effects of CMC binder viscosity and protease enzyme supplementation in drinking water influence growth performance in IPB-D1 chickens. A total of 250 unsexed chicks were randomly distributed into five treatment groups with five replicates each (10 chicks per replication). All chicks were fed commercial pre-starter and starter-grower diets formulated with varying levels of binder viscosity and enzyme supplementation.

The experimental design included five treatment groups, which were defined as follows: C0P0: Control diet without CMC or protease enzyme, C1P0: Diet with 0.5% CMC (viscosity 1000–2500 cps) and 0 mg/L protease enzyme, C1P1: Diet with 0.5% CMC (1000–2500 cps) and 10 mg/L protease enzyme in drinking water, C2P0: Diet with 0.5% CMC (2500–4000 cps) and 0 mg/L protease enzyme, C2P1: Diet with 0.5% CMC (2500–4000 cps) and 10 mg/L protease enzyme in drinking water. The protease enzyme used had an activity of 25.000 units/g. Supplementation in the drinking water at 10 mg/L corresponded to an enzymatic activity of approximately 250 units/L.

Chicks were provided unrestricted access (ad libitum) to both feed and water over a 49 days experimental period. Commercial pre-starter and starter grower rations were used, adjusted according to treatment requirements. Feed intake was measured by calculating the residual feed from the total amount of feed offered. Performance parameters evaluated included feed and water intake, body weight gain, feed conversion ratio (FCR), and mortality.

The experiment followed a Completely Randomized Design (CRD). Statistical data was carried out using SPSS Statistics for Windows, Version 25.0. Data were analyzed via one-

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way analysis of variance (ANOVA), and significant differences among treatment groups were evaluated using Tukey's post-hoc test, with significance set at $P<0.05$. The ingredient content and nutritional composition of the utilized starter-grower ration in the study are detailed in Table 1.

Table 1. Ingredient content and nutritional composition of the utilized starter-grower ration.

Ingredient	Unit	Composition
Feed composition		
Yellow corn	%	59.00
Rice bran	%	6.55
Corn gluten meal	%	6.50
Soybean meal	%	16.50
Meat and bone meal	%	6.00
Crude palm oil	%	3.00
CaCO3	%	0.06
NaCI	%	0.20
Premix	%	0.50
L-Lysine	%	0.45
DL-Methionine	%	0.40
Trytophan	%	0.10
Total	%	100.00
Aditive CMC	%	0.50
Nutrient content		
Dry Matter	%	85.57
Ash	%	5.09
Crude Protein	%	19.23
Crude Fiber	%	1.38
Ether extract	%	1.99
Beta-N	%	57.88
ME	Kcal kg^{-1}	3712

CMC = Carboxymethyl Cellulose, ME = Metabolizable Energy.

3 Results

The chickens were subjected to several treatments consisting of combinations of protease enzymes and binders with varying viscosity levels. Performance was assessed based on parameters such as feed intake, water intake, body weight gain, feed conversion ratio (FCR), and mortality rate. The results detailing the growth performance of IPB-D1 chickens throughout the pre-starter, starter, and grower phases are presented in Table 2.

Table 2. Chicken performance during the 1- 49 day period.

Treatment	Feed Intake (g chick $^{-1}$)	Drink Intake (ml chick $^{-1}$)	Weight Gain (g chick $^{-1}$)	FCR	Mortality Rate (%)
Pre-starter period					
C0P0	222.50±14.75	364.60±62.60	116.22±9.97	1.92±0.12	0
C1P0	209.54±11.65	387.60±15.37	103.21±1.52	2.03±0.10	0
C1P1	219.28±16.27	411.00±57.06	105.76±8.46	2.08±0.19	0
C2P0	222.06±6.68	320.20±46.22	111.92±6.16	1.99±0.10	0
C2P1	221.00±14.92	406.20±44.08	118.84±5.15	1.86±0.12	0
Starter period					
C0P0	388.51±11.65	778.00±69.22	187.93±39.40	2.14±0.12	0
C1P0	374.88±10.10	769.00±115.83	175.00±08.61	2.19±0.09	0
C1P1	376.92±11.80	797.60±60.54	188.33±28.64	2.05±0.38	0
C2P0	400.18±11.06	798.80±67.52	193.32±17.48	2.08±0.14	0
C2P1	393.62±33.04	873.00±78.47	178.03±08.21	2.15±0.13	0.02
Grower period					
C0P0	1056.42±72.50	2578.75±390.59	322.49±55.28	3.34±0.53	0
C1P0	1080.32±47.43	2618.00±342.28	335.67±64.13	3.42±0.86	0
C1P1	1106.93±101.34	2517.80±273.48	351.54±21.34	3.17±0.46	0
C2P0	1106.66±59.49	2466.75±136.25	348.20±29.43	3.15±0.38	0
C2P1	1058.92±48.03	2625.00±254.53	354.36±57.20	3.05±0.47	0

C0P0 = Control feed, C1P0 = 0.5% binder CMC F1501P (viscosity 1000-2500 cps) + enzyme protease 0 mg/liter, C1P1 = 0.5% binder CMC F1501P + enzyme protease 10 mg/liter, C2P0 = 0.5% binder CMC F3000P (viscosity 2500-4000 cps) + enzyme protease 0 mg/liter, C2P1 = 0.5% binder CMC F 3000P + enzyme protease 10 mg/liter.

3.1 Chicken performance during the pre-starter period (1-14 days)

The research results during the pre-starter phase (1-14 days), IPB D1 chickens were fed a commercial diet without treatment feed or binder supplementation but received protease enzyme in the drinking water. Parameters evaluated included feed intake, water intake, body weight gain, feed conversion ratio (FCR), and mortality.

According to the data shown in Table 2, feed intake ranged from 209.54 to 222.50 g chick $^{-1}$, while drink intake ranged from 320.20 to 411.00 mL chick $^{-1}$. Body weight gain was relatively consistent across birds, ranging from 103.21 to 118.84 g chick $^{-1}$. The FCR during this period ranged from 1.86 to 2.08. No mortality was recorded during the pre-starter phase, indicating good adaptation to the basal commercial diet and overall health stability during early growth.

3.2 Chicken performance during the starter period (14-28 days)

As presented in Table 2, there were no significant differences in the performance of IPB-D1 chickens among the treatment groups during the starter phase (14-28 days). Feed intake ranged from 374.88 to 400.18 g chick^{-1}, while drink intake ranged from 769.00 to 873.00 mL chick $^{-1}$. Body weight gain showed minot variated from 175.00 to 193.32 g chick $^{-1}$, and the FCR for this group ranged from 2.05 to 2.19. No mortality was observed during this phase, except for one chick in the C2P1 treatment group, which was deemed unrelated to the experimental treatment.

3.3 Chicken performance during the grower period (28-49 days)

During the grower phase (28-49 days), the performance of IPB-D1 chickens evaluate, as shown in Table 2. Feed intake varied between 1056.42 to 1106.93 g chick $^{-1}$. Body weight gain ranged from 322.49 to 354.36 g chick $^{-1}$. Notably, chickens receiving protease supplementation (C1P1 and C2P1) showed the highest weight gain, particularly in the C2P1 group (358.34 g chick $^{-1}$), which received the high-viscosity binder combined with enzyme inclusion.

Drink intake followed a similar trend, ranging from 2466.75 to 2625.00 mL chick $^{-1}$, with the highest value recorded in the C2P1 group. The FCR during this period ranged from 3.05 to 3.42, and the enzyme protease-supplemented groups (C1P1 and C2P1) demonstrated improved FCR values (3.05-3.17) compared to birds not receiving enzyme supplementation (3.17-3.42), suggesting that protease inclusion positively influenced nutrient utilization and growth efficiency during the grower phase. No mortality occurred in any treatment group during this period, confirming that all feed formulations and enzyme dosages were well-tolerated and safe for the birds.

4 Discussion

The present findings indicate that the use of carboxymethyl cellulose (CMC) binder viscosity and protease enzyme supplementation via drinking water had no statistically significant effects across all growth phases of IPB-D1 chickens. This lack of significant differences is consistent with previous studies by Walk and Poernama [8], which suggest that factors such as nutrient adequacy, substrate specificity, and enzyme dosage may influence the observed outcomes.

During the grower phase (29–49 days), the treatment group receiving a CMC binder with a viscosity range of 2500–4000 cps combined with 10 mg/L of protease enzyme supplementation exhibited the highest body weight (354.36 g chick $^{-1}$) and the most efficient feed conversion ratio (FCR = 3.05). These results suggest that the synergistic effect of a high-viscosity binder and protease enzyme become more significant in the later growth stages, likely due to the more developed digestive physiology of older chickens, which enhances the utilization of functional feed additives.

In contrast, the group that did not receive enzyme supplementation showed the lowest performance, with the highest FCR (3.42) and the lowest body weight gain (322.49 g chick $^{-1}$). This reinforces the importance of protease enzymes in improving protein digestion during periods of rapid growth. These findings align with previous research by Coewison et al. [9], which reported that protease enzymes in drinking water enhance protein hydrolysis into absorbable amino acids, thereby promoting increased feed intake and improved growth performance. Furthermore, a meta-analysis by Ridla et al. [10] concluded that feed binders do not directly affect broiler performance, but instead primarily improve the physical properties of feed, such as pellet durability and stability.

5 Conclusion

The use of CMC binder in pellet feed and the supplementation of protease enzyme through drinking water did not significantly affect growth performance at any phase. However, descriptively, the protease enzyme showed a positive effect during the grower phase by increasing body weight and reducing FCR.

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