



Effectiveness Of Local Probiotic Enzyme Fermented Feeddigestion On The Production And Quality Of Eggs From Local Hybrid Chickens In The Laying Phase

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ABSTRACT

Improving the egg productivity and quality of local hybrid chicken is an important strategy in the development of sustainable poultry farming in Indonesia. This study aims to evaluate the effectiveness of fermented diet enriched with local probiotics and digestive enzymes on egg production and quality of local hybrid chicken during the laying phase. The study was conducted at the Field Laboratory of Animal Husbandry, Syiah Kuala University and the Laboratory of Animal Physiology and Reproduction Teuku Umar University, using 120 chickens resulting from the crossbreeding of female ALPU and male KUB F2. The research design used a completely randomised method with 4 treatments and 5 replicates: P0 (100% commercial diet), P1 (100% fermented diet), P2 (50% fermented diet + 50% commercial diet), and P3 (30% fermented diet + 70% commercial diet). The results showed that treatment P1 had a significant effect ($P < 0.05$) on egg production, egg weight, and egg yolk colour score. However, no significant differences were observed in clutch size, shell thickness, and egg grade. The effectiveness of fermented diet is thought to stem from improved digestibility and nutrients absorption due to the presence of probiotics and digestive enzymes. Treatments P2 and P3 showed that the result was equivalent to that of on commercial diet. Overall, fermented diet enriched with probiotic and digestive enzymes proved to be an effective to stimulate egg production and quality on local hybrid laying chickens. In addition, this findings could be an economical alternative for improving the production and quality of eggs from local hybrid chickens in the early laying phase.

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1. Introduction [Heading of Section]

Egg consumption in Indonesia increased from 107,770 eggs per capita in 2019 to 115,503 eggs in 2024, an increase of 6.69%. This phenomenon requires egg farmers to optimise egg production and quality, especially from local hybrid chickens that are known especially from local hybrid chickens known for their good adaptability to the environment. One important strategy is to improve diet quality through the use of local material on composition of fermentation diet and the addition probiotic and digestive enzymes.

Local hybrid chickens have great potential in the poultry industry due to their ability to produce high-quality eggs at a relatively low maintenance cost. However, the main challenges are the high feed cost and the low digestibility of local feed ingredients. To overcome this, fermented diet formulations based on local probiotics and exogenous digestive enzymes are needed as an innovative solution.

Local hybrid chickens have great potential in the poultry industry due to their ability to produce high-quality eggs at a relatively low maintenance cost. However, the main challenges faced are the high cost of feed and the low digestibility of local feed ingredients. To overcome this, the formulation of fermented feed based on local probiotics and exogenous digestive enzymes is a promising innovative solution. Fermentation diet of chicken with microorganisms such as *Lactobacillus crispatus*, *Lactobacillus salivarius*, and *Clostridium butyricum* has been shown to improve production performance and gut health in laying hens. Research by Lv et al. (2021) indicated that supplementing 6% of fermented diet with probiotic fermentation can significantly improve feed efficiency and egg quality. Probiotics also play a role in modulating the gut microbiota and producing bioactive compounds that support digestive health (Xiang et al., 2019).

On the other hand, the addition of digestive enzymes such as phytase and xylanase has been shown to improve phosphorus utilisation, metabolic energy, and egg quality. A study by Kayan et al. (2025) showed that supplementation with these enzymes can significantly increase shell thickness, egg weight, and feed efficiency. In addition, the use of prebiotics such as lactulose has also been shown to improve digestive enzyme activity and egg quality through improved intestinal morphology and digestive gene expression (Elkomy et al., 2023). Egg quality is greatly influenced by feed nutrition. Quality parameters include shell thickness, albumen height, yolk colour, and Haugh Unit (HU) value, which reflects egg freshness. Egg quality evaluation is conducted using an egg analyser that measures egg weight, albumen height, yolk colour, and HU (Yaman et al., 2023).

Although enzymes can be produced endogenously by chickens, the addition of exogenous enzymes is still necessary to increase nutrient of diet utilisation in feed. Therefore, this study aims to evaluate the effectiveness of a combination of locally fermented probiotic feed and digestive enzymes on the production and quality of eggs from local hybrid layer chickens as a strategy to improve the efficiency of local layer farming.

MATERIALS AND METHODS

This research was conducted over a period of six months, from January to June 2025. Chicken maintenance and feeding activities were carried out at the Field Laboratory of Animal Husbandry (LLP), Faculty of Agriculture, Syiah Kuala University. Egg quality analysis was conducted at the Laboratory of Animal Physiology and Reproduction, Department of Animal Science, Teuku Umar University, Aceh, Indonesia.

MATERIAL

The main subject of this study was local hybrid layer chickens that were fed fermented diet based on local probiotics and exogenous digestive enzymes. The probiotics used were derived from local microbial isolates such as *Lactobacillus salivarius* and *Clostridium butyricum*, which have been shown to improve production performance and gut health in laying hens (Lv et al., 2021; Xiang et al., 2019). The digestive enzymes used include phytase and xylanase, which function to improve nutrient digestibility and feed utilisation efficiency (Kayan et al., 2025).

The treatments diet was formulated using fermented local feed ingredients, combined with probiotic and digestive enzymes, and designed to meet the nutritional requirements of local hybrid layer-phase chickens. Details of the diet ingredients, formulation, and nutritional composition are presented in Table 1:

Table 1. Research ration feed formulation

| No | Material | Percentage (%) |
|-------|---------------------|----------------|
| 1 | Rice bran | 14 |
| 2 | Soybean meal (SBM) | 12 |
| 3 | Corn | 51 |
| 4 | Meat meal | 6 |
| 5 | Poultry mineral mix | 1 |
| 6 | Sago flour | 2 |
| 7 | Shrimp head meal | 6 |
| 8 | Leucaena leaf meal | 6 |
| 9 | Enzim zymax | 1.2 |
| 10 | L- lysine | 3 |
| 11 | Probiotic | 0.05 |
| 12 | DL-Methionine | 0.45 |
| Total | | 100 |

Table 2. Feed Formulation and Nutritional Value

| No | Material | Treatment | | | |
|-------|--------------------|-----------|------|------|------|
| | | P1 | P2 | P3 | P4 |
| 1 | RK (%) | 0 | 50 | 30 | - |
| 2 | Paferproen (%) | 0 | 100 | 50 | 70 |
| | Number (%) | 100 | 100 | 100 | - |
| 3 | Nutritional Value | | | | |
| | a. Protein (%) | 18 | 20 | 19 | - |
| | b. EM (kkal) | 2700 | 3321 | 3312 | - |
| | c. Crude fibre (%) | 7 | 5.75 | 3.87 | 4.51 |
| | d. Coarse fat (%) | 7 | 6.28 | 6.29 | 6.00 |
| Total | | 100 | | | |

Description: RK 324-1: Diet from PT. Charoen Phophand, Paferproen: Local diet, The source of analysis: Industrial Services and Standardisation Agency, Banda Aceh,2024.

RESEARCH METHODOLOGY

This study began with the preparation of the tools and materials needed for all stages of the activity. Organic feed materials were collected as the basic components of layer feed, then mixed and fermented anaerobically for 21 days. A total of 120 F2 hybrid local chickens (ALH) were used as experimental animals, all of which were female. The chickens were placed in prepared cages and treated for 150 days. The study used a completely randomised design (CRD) with four treatments and five replicates. Feed was provided three times a day, at 07:00, 14:00, and 18:00 WIB. Drinking water was provided ad libitum. The feed treatment consisted of a combination of locally sourced probiotic-based fermented feed and exogenous digestive enzymes, which were administered according to the following formulation levels:

P0: Administration 100% commercial diet,

P1: Administration 100% local probiotic fermented diet and digestive enzymes,

P2: Administration 50% local probiotic fermentation and digestive enzymes with the 50% commercial and

P3: Administration 30% local probiotic fermentation and digestive enzymes with added 70% commercial diet.

OBSERVED PARAMETERS

Physical quality parameters of the exterior of the egg include: egg production, clutch, egg weight, and eggshell thickness.

Physical quality parameters of the egg interior include: yolk, albumen (egg white), yolk colour, HU (Haugh unit) and egg grade. Egg quality is measured using an egg analyser of the brand ORKA Food Technology, Amerika Serikat (USA) dan digital thickness merek Mitutoyo, Jepang.

RESULTS AND DISCUSSION

Egg production is a physiological process that occurs in female chickens, both for commercial purposes and household consumption. The main factors that influence egg production include genetic and environmental factors, particularly the availability and quality of feed (Goto et al., 2019). This is reinforced by Abdel et al. (2021), who state that the productivity of laying hens is not only influenced by genetic factors, but also by feed formulation, including the use of fermented feed.

A nutritional approach through the provision of fermented feed enriched with probiotics, such as *Lactiplantibacillus plantarum*, has been shown to significantly increase egg production (Zhang et al., 2022). Egg production in chickens begins when they reach sexual maturity, which is around six weeks of age (Alam et al., 2008). Based on the observations in this study, egg production showed a significant increase significantly by feeding on fermented diet contamel probiotic and digestive enzyme.

Table 3. Egg Production Local Hybrid Chicken

| No | Parameters | Treatment | | | |
|----|----------------------------------|-------------|-------------|--------------|-------------|
| | | P1 | P2 | P3 | P4 |
| 1 | Percentage of Egg Production (%) | 65.00±3.25a | 83.00±2.55b | 74.00±3.30ab | 69.00±2.60a |
| 2 | Egg Clutch (day/month) | 22.63±2.07 | 29.13±1.89 | 26.00±2.33 | 24.23±2.19 |

Description: a, b superscripts indicate significant differences (P<0.05).

Based on Table 3, feeding 100% fermented diet (P1) significantly increased the percentage of egg production in local hybrid chickens compared to the control group (P0) and treatment P3 (P<0.05). The highest production percentage was recorded in P1 at 83.00 ± 2.55%, while P0 only reached 65.00 ± 3.25%. The P2 and P3 treatments showed results of 74.00 ± 3.30% and 69.00 ± 2.60%, respectively, with P2 not significantly different from the other treatments. In terms of egg clutch parameters (number of days of egg laying per month), P1 also showed the best performance with an average of 29.13 ± 1.89 days/month. This value was higher than P0 (22.63 ± 2.07), P2 (26.00 ± 2.33), and P3 (24.23 ± 2.19). These data indicated that chickens in treatment P1 have a longer and more consistent laying cycle. The increase in egg production and clutch duration in treatment P1 demonstrates the effectiveness of fermented feed enriched with probiotics and digestive enzymes in optimising nutrient absorption. Probiotics such as *Lactiplantibacillus plantarum* play a role in maintaining gut microbiota balance, enhancing immunity, and preventing pathogenic bacterial colonisation, thereby supporting feed-to-egg conversion efficiency (Naeem and Bourassa, 2025; Idowu et al., 2025; Wu et al., 2025).

The effectiveness of probiotics in improving production performance has also been proven by Aghaii et al. (2010), who showed that probiotic supplementation in laying hen feed significantly increased egg production and egg mass, and reduced feed conversion ratio. The addition of probiotics also improved egg weight, shell strength, and Haugh Unit value, and reduced plasma and egg yolk cholesterol levels. Digestive enzymes such as phytase and xylanase help break down complex compounds in feed into simpler, more easily absorbed forms, thereby improving metabolic efficiency and nutrient availability for egg production. Research by Kayan et al. (2025) showed that supplementation with phytase and xylanase significantly improves production performance, egg quality, and the efficiency of phosphorus and metabolic energy utilisation in laying hens.

The optimal dosage (100% of fermented diet) provides the best results, while combining it with commercial diet in higher proportions actually reduces efficiency. This indicated that the benefits of fermented diet are non-linear and can decrease if not formulated correctly. The longer clutch duration in P1 also shows a more stable and intensive production pattern. According to Kaye et al. (2017), clutch length contributes 72% to the variation in the number of eggs produced, while 28% is influenced by feed quality, including probiotics and digestive enzymes. The circadian cycle that regulates oviduct rhythm

and laying rest time also plays a role in determining the number of eggs in a clutch period (Yaman et al., 2024). Overall, these results indicated that fermented diet based on local probiotics and digestive enzymes is an effective and economical alternative for improving the productivity of local hybrid laying hens.

EGG QUALITY

Feeding 100% fermented feed (P1) had a positive effect on the quality of F1 hybrid local chicken eggs. The highest egg weight was recorded in the P1 treatment at 54.88 g, which was significantly different ($P < 0.05$) compared to P3 (47.31 g), but not significantly different from P0 and P2. Eggshell thickness did not show significant differences between treatments, with values ranging from 0.36 mm to 0.38 mm.

In terms of egg interior quality parameters, the highest egg yolk scores were obtained in treatments P2 and P3, at 11.63 ± 0.52 and 11.63 ± 0.74 , respectively, which were significantly different from P0 (9.38 ± 1.77). The highest albumin height was recorded in P1 (4.39 ± 0.73 mm), which was significantly different from P0 and P2. The highest Haugh Unit (HU) value was also found in P1 (65.19 ± 6.10), indicating better albumin quality compared to other treatments.

Table 4. Quality of F1 Hybrid Local Chicken Eggs

| No | Parameters | Treatment | | | |
|----|--------------------------|-------------------|---------------------|--------------------|---------------------|
| | | P1 | P2 | P3 | P4 |
| A | Egg Quality | | | | |
| 1. | Egg Weight | 51.36ab | 54.88b | 50.59ab | 47.31a |
| 2. | Thickness of egg shell | 0.38 | 0.36 | 0.36 | 0.37 |
| B | Interior Quality of Eggs | | | | |
| 1. | Egg yolk Score | $9.38 \pm 1.77a$ | $10.63 \pm 0.74 ab$ | $11.63 \pm 0.52 b$ | $11.63 \pm 0.74 b$ |
| 2. | Albumin (mm) | $3.59 \pm 0.53 a$ | $4.39 \pm 0.73 b$ | $4.39 \pm 0.73 b$ | $3.64 \pm 0.95 a$ |
| 3. | Haugh unit (HU) | $58.81 \pm 4.96a$ | $65.19 \pm 6.10ab$ | $58.46 \pm 12.54a$ | $60.28 \pm 13.58ab$ |
| 4. | Grade | 3.38 ± 0.52 | 3.88 ± 0.64 | 3.63 ± 0.74 | 3.63 ± 0.74 |

The increase in egg weight, albumin height, and HU value in treatment P1 indicated that fermented diet enriched with probiotics and digestive enzymes can improve metabolic efficiency and nutrient absorption, which directly impacts egg quality. Probiotics play a role in maintaining gut microbiota balance, improving gastrointestinal health, and improving feed conversion into egg components (Naeem and Bourassa, 2025; Idowu et al., 2025).

Digestive enzymes such as phytase and xylanase help break down complex compounds in diet, making nutrients such as protein and minerals easier to absorb and use in the formation of albumin and egg yolk. Research by Kayan et al. (2025) shows that exogenous enzyme supplementation significantly improves egg interior quality, including HU value and albumin height.

The higher egg yolk scores in treatments P2 and P3 indicated that although the proportion of fermented diet was lower than in P1, the combination with commercial diet still contributed to an increase in pigment and egg yolk quality. This can be attributed to the carotenoid and antioxidant content in fermented diet ingredients that play a role in yolk colouration (Aghaii et al., 2010). Overall, these results indicate that fermented diet based on local probiotics and digestive enzymes not only increases egg production quantity but also improves the physical and functional quality of eggs. The increase in HU value and albumin height are important indicators in assessing egg freshness and quality, which are highly relevant in the poultry industry and consumer market.

EGGSHELL QUALITY

Eggshell thickness was measured using a screw micrometer with an accuracy of 0.001 mm (Gong

et al., 2022). The results of the analysis of variance showed that the local probiotic fermented diet probiotic and digestive enzyme treatments had no significant effect ($P > 0.05$) on eggshell thickness. Table 4 showed that treatment P0 had the highest mean (0.38 mm), although all treatments were within the normal range. Although not significant, shell quality is still influenced by the availability of minerals such as calcium and phosphorus. Probiotics help create a healthy intestinal environment and increase mineral solubility through lactic acid production (Latif et al., 2023). Digestive enzymes, particularly phytase, play a role in breaking down phytic acid bonds that bind phosphorus and calcium, thereby increasing their bioavailability (Mussa et al., 2023).

This combination of probiotics and enzymes can provide greater benefits to chickens experiencing stress or in the final stages of production, when mineral absorption efficiency declines. Thus, although not statistically significant, this nutritional approach remains relevant for maintaining eggshell quality and durability.

EGG YOLK COLOUR SCORE

The results showed that chicken feed on a fermented diet probiotic active digestive enzymes had a significant effect on the yolk colour score of local hybrid chickens. Treatments P2 and P3 produced the highest scores, 11.63 ± 0.52 and 11.63 ± 0.74 , respectively, which were significantly different (P2 and P3). This increase in egg yolk colour score indicates that the combination of probiotics and digestive enzymes in fermented feed can enhance the absorption of essential nutrients such as carotenoids, protein, and energy, which play a role in yolk pigment formation. According to Aftab et al. (2020), the use of fermented diet at a level of 30–50% is the optimal dose for maximising yolk content, as probiotics and enzymes work synergistically to improve metabolic efficiency and nutrient absorption.

Fermented corn-based feed also contributes to the enhancement of egg yolk colour due to its high xanthophyll content, such as lutein and zeaxanthin, which are natural pigments that make up the yellow colour (Song et al., 2023). The ideal yolk colour ranges from 9–12 according to the Yolk Colour Fan standard, and is influenced by the cryptoxanthin content in fermented feed (ITPSA, 2024). Other factors that influence yolk pigmentation include feed quality, gut health, and nutrient absorption efficiency. Kljak et al. (2021) emphasise that the physiological condition of chickens and feed formulation play a crucial role in pigment deposition into egg yolks. Probiotics in fermented feed increase the population of beneficial bacteria that improve intestinal morphology and enhance carotenoid absorption (Halder et al., 2024). Digestive enzymes such as xylanase and beta-glucanase play a role in breaking down plant cell walls, releasing trapped xanthophyll pigments, making them easier to absorb and deposit into egg yolks. Rahayu and Retnaningrum (2025) also showed that fermented feed increases protein and mineral levels, which supports pigment synthesis and yolk colour quality.

HIGH EGG WHITE SCORE (ALBUMIN)

The results showed that treatment P1, which was 100% local probiotic fermented diet enriched with probiotic and digestive enzymes, produced the highest albumin score of $4.39 \pm 0.73b$. This value was significantly different ($P < 0.05$) compared to treatments P0, P2, and P3, which showed lower scores and were not significantly different from each other. The low albumin scores in P0, P2, and P3 were thought to be influenced by suboptimal egg storage conditions, particularly low temperature and humidity, which can cause water loss and a decline in albumin quality (Obianwuna et al., 2022). According to Ribeiro et al. (2021), the albumin index is the ratio between the height and width of the egg white, which reflects the freshness and quality of egg protein. The increase in albumin scores at P1 indicates that the combination of probiotics and digestive enzymes plays an important role in improving feed protein digestion and absorption efficiency, thereby supporting optimal albumin synthesis (Lv et al., 2021).

Conversely, low scores in treatments P0, P2, and P3 can be attributed to the presence of antinutritional compounds such as tannins and phytates in feed ingredients that have not been completely degraded. These compounds are known to bind with proteins and essential minerals, forming complexes that are difficult for chickens to digest and absorb (Samtiya et al., 2020). As a result,

even though the feed has a high protein content, the availability of amino acids for albumin synthesis becomes limited.

Yusuf et al. (2019) explain that antinutrients such as tannins, phytates, and trypsin inhibitors can interfere with the digestion and absorption of essential nutrients. Phytate, in particular, can bind calcium, zinc, and protein, thereby reducing their bioavailability. Eichman et al. (2024) add that tannins can also bind digestive enzymes and feed proteins, reducing protein breakdown efficiency and affecting albumin quality. Furthermore, high levels of non-starch fibre in diet can increase intestinal viscosity, slowing down the digestion and absorption of nutrients, including essential amino acids that are crucial for albumin formation (Aftab et al., 2018). Therefore, diet formulation that takes into account antinutrient levels is essential for maintaining optimal albumin quality in laying hen eggs.

HAUGH UNIT (HU)

Data on egg interior quality indicate that treatment with locally fermented diet probiotic and digestive enzymes has a significant effect on the Haugh Unit (HU) value of local hybrid chicken eggs. Based on statistical analysis, treatments P1 (65.19 ± 6.10) and P3 (60.28 ± 13.58) produced higher HU values compared to the control P0 (58.81 ± 4.96) and P2 (58.46 ± 12.54). Although the HU values between P1 and P3 were not significantly different, both showed better albumen quality, indicating that the fermented diet formulation at that level 70% was effective in maintaining egg white viscosity.

HU value is an important indicator in assessing the internal quality of eggs, particularly the viscosity of the albumen, which is influenced by genetic factors, hen age, and feed composition (Allaily et al., 2023). The increase in HU in treatments P1 and P3 is consistent with findings that fermented feed rich in probiotics and with high nutrient bioavailability can improve gastrointestinal health and the efficiency of essential amino acid absorption required for the synthesis of albumen proteins, such as ovomucin and ovalbumin (Zhu et al., 2020).

Ovomucin is the main component in the albumen gel structure and plays a role in determining the viscosity of egg white. High ovomucin stability and concentration are directly correlated with increased HU values. Fermented diet also contains hydrolysed nutrients and probiotics that support gut microbiota balance, improve villi morphology, and increase protein absorption (Lv et al., 2021).

Tumu et al. (2024) in their meta-analysis review stated that prebiotic and probiotic supplementation consistently improves egg internal quality, including HU, through more efficient protein metabolism pathways. Thus, treatments P1 and P3 indicated that fermented diet can optimise albumen synthesis and produce eggs with higher viscosity.

GRADE EGG

Based on Table 4, chicken fed on diet fermented diet combined with local probiotics and digestive enzymes had a positive effect on the egg grade of F2 hybrid local chickens. Treatment P1, which used 100% fermented diet, produced the highest egg grade with an average of 3.88 ± 0.64 . In contrast, the control treatment (P0), which used commercial feed, showed the lowest egg grade, namely 3.38 ± 0.52 . Treatments P2 and P3 also showed a significant increase in egg grade compared to P0, with average values of 3.63 ± 0.74 , respectively. The increase in egg grade in treatment P1 indicated that the fermented diet formulation enriched with probiotics and digestive enzymes can improve overall egg quality. According to Khan et al. (2019), fermented diet containing probiotics and enzymes contributes to an increase in shell thickness and egg weight, two important parameters that affect egg grade assessment.

Olukomaiya et al. (2020) added that enzymes in fermented diet increase the availability of minerals and vitamins, which play a role in shell formation and egg interior quality. The fermentation process also supports gastrointestinal health by increasing the population of beneficial gut microbiota, thereby supporting albumen protein synthesis and overall egg quality (Wu et al., 2018). Egg grade is also influenced by the viscosity and clarity of the albumen, which is closely related to protein synthesis such as ovomucin. Rahman et al. (2019) explain that increasing nutrient bioavailability through feed fermentation can optimise egg protein synthesis, resulting in a thicker and clearer albumen, as well as improving egg grade scores. Tumu et al. (2024) in their meta-analysis stated that diet modifications that

improve gut health, such as fermentation, significantly contribute to improving internal quality and egg grade

CONCLUSION

Based on the results of the study, it can be concluded that fermented diet enriched with local probiotics and digestive enzymes was a highly effective alternative to commercial diet in the rearing of local hybrid layer chickens. This diet formulation has been proven to significantly improve egg productivity and quality, both in terms of production quantity and the physical and functional quality parameters of the eggs. The Chicken fed on fermented feed shows an increase in feed consumption and digestibility efficiency, which has a direct impact on production performance and egg quality. This effectiveness includes improvements in egg weight, yolk colour score, albumin height, Haugh Unit value, and egg grade. Thus, the use of fermented diet probiotics and digestive enzymes not only supports the sustainability of local poultry production systems but also has the potential to provide higher economic benefits for farmers of local hybrid chicken.

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