



Effect of Pineapple Peel Probiotics in Drinking Water on The Production Performance and Egg Quality of Quail

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui pengaruh penambahan probiotik kulit nanas dalam air minum terhadap produktivitas dan kualitas telur puyuh. Materi yang digunakan adalah puyuh strain Peksi umur 12 minggu sebanyak 240 ekor dan probiotik kulit nanas yang mengandung bakteri *Lactobacillus casei*. Penelitian menggunakan Rancangan Acak Lengkap dengan 6 perlakuan pemberian probiotik kulit nanas pada air minum dengan jumlah 0% (P0), 1%/liter (P1), 2 %/liter (P2), 3 %/liter (P3), 4 %/liter (P4), 5 %/liter (P5). Parameter yang diamati terdiri konsumsi pakan, produksi telur harian, bobot telur, dan konversi pakan serta kandungan lemak kolesterol telur. Data dianalisis dengan analisis varian apabila terdapat perbedaan antar perlakuan dilanjutkan dengan uji Duncan. Penambahan probiotik kulit nanas dalam air minum tidak berpengaruh ($P>0.05$) terhadap peningkatan konsumsi pakan, produksi telur harian, bobot telur serta penurunan konversi pakan, kadar lemak dan kolesterol telur puyuh. Hasil penelitian menunjukkan pemberian probiotik kulit nanas pada air minum dapat meningkatkan produksi telur harian pada puyuh.

ABSTRACT

This study aimed to evaluate the effects of adding pineapple peel probiotics to drinking water on quail productivity and egg quality. The experiment used 240 Peksi strain quails, aged 12 weeks, and pineapple peel probiotics containing *Lactobacillus casei*. A completely randomized design was applied, with six treatment groups receiving varying concentrations of pineapple peel probiotics in drinking water: 0% (P0), 1%/liter (P1), 2%/liter (P2), 3%/liter (P3), 4%/liter (P4), and 5%/liter (P5). The observed parameters included feed consumption, hen-day production (HDP), egg weight, feed conversion ratio, and the fat and cholesterol content of the eggs. Data were analyzed using ANOVA, followed by Duncan's test for post-hoc comparisons where significant differences were observed. The addition of pineapple peel probiotics in drinking water did not significantly affect ($P>0.05$) feed consumption, daily egg production, egg weight, feed conversion ratio, or the fat and cholesterol content of the eggs. However, supplementation at pineapple peel probiotics in drinking water to can daily egg production in quails.

1. Introduction

Quail farming (*Coturnix japonica*) presents a promising opportunity to meet Indonesia's growing demand for animal protein. With their rapid growth, high egg production, and suitability for small-scale farming, quails offer an efficient source of protein. Quail eggs contain approximately 13% protein, surpassing the 11% found in chicken eggs (Suwarta and Suryani, 2019). They are also nutrient-dense, rich in iron, vitamin A, and B12, making them a valuable food source for improving the nutritional intake of Indonesians (Anggaeni *et al.*, 2023). In 2023, quail egg production in Indonesia reached 22,399.15 tons, marking a 1.74% increase from the previous year. This growth highlights the significant potential and increasing popularity of quail as a sought-after poultry commodity in the country.

One of the challenges of quail farming is their susceptibility to stress and disease, which can lead to reduced productivity. To maintain optimal productivity, the feed provided must meet the nutritional requirements of the livestock. Feed additives, such as antibiotic growth promoters (AGPs), have traditionally been used to enhance growth. However, the use of AGPs has been linked to negative effects, including the development of antibiotic-resistant bacteria, antibiotic residues in eggs (Tribudi and Nurfiанти, 2017), toxicity, and environmental impact (Etikaningum and Iwantoro, 2017). Due to these concerns, the use of AGPs was banned in Indonesia as of January 2018 under Regulation PERMENTAN RI Number 14/PERMENTAN/PK.350/5/2017, which classifies veterinary drugs. This ban has prompted the search for alternative solutions, such as the use of probiotics (Permentan, 2017).

Probiotics are supplements containing live microorganisms that offer health benefits to the host's digestive system (Akter *et al.*, 2022; Gomez-Garcia *et al.*, 2022). One promising source of probiotics in animal feed is derived from agricultural by-products, such as pineapple peels. Rich in sugars like sucrose, glucose, and fructose, as well as dietary fiber and organic acids like citric acid (Mehraj, 2024), pineapple peels provide both energy and an optimal environment for probiotic bacteria to thrive. As a prebiotic substrate, pineapple peel supports the growth of beneficial bacteria, including *Lactobacillus rhamnosus* and *Lactobacillus plantarum*, which can reach maximum populations (Akter *et al.*, 2022). The prebiotic properties of pineapple peel flour enhance the metabolic functions of these bacteria, improving their ability to produce beneficial

enzymes (Sivanesan *et al.*, 2022). Additionally, pineapple peel-derived probiotics have been found to produce compounds that contribute to better poultry health and productivity (Chacon *et al.*, 2024; Mehraj *et al.*, 2024). Research indicates that incorporating pineapple peel probiotics into laying hens diets can improve egg quality (Hidayat *et al.*, 2020), health (Akter *et al.*, 2021; Lubaina *et al.*, 2019; Sukri *et al.*, 2023), and overall productivity (Owoeye *et al.*, 2022; Polania *et al.*, 2022). However, the use of pineapple peel as a probiotic source in quail has not been extensively studied. This study aimed to explore the effects of pineapple peel probiotics in drinking water on quail productivity and egg quality.

2. Material and Methods

2.1 Research Materials

This study utilized 240 Peksi strain laying quails, each aged 3 months with an average body weight of 158.3 ± 11.4 g. The quails were fed a specialized feed for laying quail, SP 22-E, produced by PT Sinta Prima Feedmill. The feed had a crude protein content of 20-22%, crude fat 7%, crude fiber 7%, moisture content 12%, ash 14%, calcium 3-3.5%, and phosphorus 0.6-1%. The quails were reared for 3 months. The equipment used in this study included battery cages equipped with feed and water containers, along with digital scales for measuring body weight.

2.2 Preparation of Probiotics from Pineapple Peel

*2.2.1 Rejuvenation of *Lactobacillus casei* (Lestari et al., 2023)*

Bacterial activation began with a microtube containing 400 μ L of *Lactobacillus casei* and 600 μ L of sterile glycerol. The bacteria were then refreshed in 10 mL of MRS Broth by dissolving 0.52 g of media in 10 mL of distilled water. After sterilization, the mixture was incubated for 48 hours at room temperature. The rejuvenation process continued by transferring the grown bacteria into 100 mL of MRS Broth, followed by an 8-hour incubation at 37°C. After the 8-hour incubation, the 100 mL bacterial culture in MRS Broth was added to 900 mL of fresh MRS Broth.

2.2.2 Production of Pineapple Peel Probiotics

The preparation of pineapple peel probiotics followed a modified version of the method by Istarisa (2022). First, pineapple peel waste was sorted and rinsed thoroughly under running water. After cleaning, 500 g of the pineapple peel was separated from the pulp. The peels were then blanched for 15 minutes. After blanching, the peels were blended with distilled water in a 3:1 ratio until the mixture became smooth and homogeneous. The resulting mixture was filtered to separate the pulp from the liquid. The pineapple peel liquid was then sterilized for 15 minutes. Finally, the sterilized liquid was mixed with a *Lactobacillus casei* bacterial starter and allowed to ferment for 6 days.

2.3 Research Design

The experiment followed a completely randomized design (CRD) with 6 treatments and 4 replicates, with each replicate consisting of 6 quails. The treatments in this study were as follows:

P₀ : Drinking water

P₁ : 1% probiotic pineapple peel juice/liter of drinking water (V/V)

P₂ : 2% probiotic pineapple peel juice/liter of drinking water (V/V)

P₃ : 3% probiotic pineapple peel juice/liter of drinking water (V/V)

P₄ : 4% probiotic pineapple peel juice/liter of drinking water (V/V)

P₅ : 5% probiotic pineapple peel juice/liter of drinking water (V/V)

2.4 Application of Probiotics in Quails

Probiotic supplementation involved extracting the probiotics according to the treatment using a syringe, glass jar, and measuring cup. The probiotics were then mixed with water, homogenized, and placed in the drinking containers. Probiotics were provided continuously ad libitum to ensure efficient and optimal results. When the drinking water approached depletion, it was replenished according to the needs of each treatment group.

2.5 Observation Parameter

The parameters measured in this study included feed consumption, daily egg production, egg weight, and feed conversion ratio, as well as the chemical quality of the eggs, specifically fat and cholesterol levels.

2.6 Data Analysis

The data obtained were analyzed using Analysis of Variance (ANOVA) with the Gestat 14.4 program. If differences significant ($P < 0.05$) among treatments were detected, further analysis was conducted using the Duncan test (Tribudi and Prihandini, 2020).

3. Result and Discussion

3.1 Production performance

The results indicated that the supplementation of pineapple peel probiotics in drinking water had no significant effect ($P > 0.05$) on feed consumption, daily egg production, egg weight, and feed conversion in quails (**Table 1**).

Table 1. Production performance of quail fed pineapple peel probiotic in drinking water

Treatment	Parameter			
	Feed consumption (g/head/day)	Egg production (%)	Egg weight (g)	Feed conversion
P ₀	19.38±0.30	62.53±9.03	9.08±0.41	2.08±0.10
P ₁	19.70±0.45	67.81±4.54	9.19±0.17	2.06±0.06
P ₂	19.65±0.34	66.00±4.01	9.11±0.70	2.07±0.07
P ₃	19.78±0.54	68.64±8.31	9.48±0.50	2.09±0.16
P ₄	19.65±0.31	74.51±2.97	9.34±0.16	2.05±0.10
P ₅	19.59±0.49	68.23±5.81	9.53±0.29	2.03±0.07

3.1.1 Feed Consumption

The average feed consumption during the study ranged from 19.38 to 19.78 g per bird per day, which was lower than reported by Ilham *et al.* (2017). However, the addition of pineapple peel probiotics to drinking water resulted in increased feed consumption among the quails. This increase can be attributed to the probiotics' ability to enhance the quails' digestive tract, thus improving growth performance and feed efficiency. The *Lactobacillus casei* bacteria present in the pineapple peel probiotics play a vital role in modulating the gut microbiota of quails, promoting a balanced environment for optimal digestion and nutrient absorption (Ahmad *et al.*, 2022; Darboe *et al.*, 2022). Additionally, probiotics enhance the colonization of beneficial bacteria while suppressing pathogenic strains, leading to improved gut health and increased feed consumption (Poberezhets *et al.*, 2023).

Probiotics stimulate the production of digestive enzymes, which enhance the breakdown of feed components. This enzymatic activity not only increases nutrient availability but also promotes higher feed consumption rates (Andrabi *et al.*, 2016; Kadam *et al.*, 2024). The inclusion of pineapple peel probiotics in quail diets can improve immune response, reduce disease incidence, and alleviate stress (Yang *et al.*, 2023; Bohatko, 2023). Healthy quails exhibit normal feeding behavior, consuming feed consistently, which contributes to improved overall production performance (Buba *et al.*, 2020; Faiqoh *et al.*, 2023). Enhanced nutrient absorption from feed leads to better animal health, encouraging greater feed intake (Ardika *et al.*, 2017). These results align with findings by Priastoto *et al.* (2016) and Neupane *et al.* (2019), who reported increased feed consumption in laying hens fed basal diets supplemented with probiotics compared to a control group without probiotics.

3.1.2 Egg Production

Egg production serves as a key indicator of quail productivity. In this study, egg production rates ranged from 62.53% to 74.51%, with an average egg weight between 9.08 and 9.53 grams. The inclusion of pineapple peel probiotics in drinking water showed a tendency to improve egg production, though the increase was not statistically significant ($P > 0.05$) with higher probiotic levels. These findings align with previous studies (Xiang *et al.*, 2019; Yousaf *et al.*, 2022; Neupane *et al.*, 2019; Peralta-Sánchez *et al.*, 2019), which reported that while various probiotics can enhance egg production in poultry, the effects were not significant.

The increase in daily egg production percentage can be attributed to the microbial activity of lactic acid bacteria present in pineapple peel probiotics. This improvement is linked to the bioactive compounds found in pineapple peel, which enhance the viability and efficacy of probiotics. These compounds promote the growth of beneficial bacteria in the digestive tract, improving overall health and nutrient utilization (Sah *et al.*, 2015). Bromelain, a proteolytic enzyme found in pineapple peel, further aids digestion by enhancing nutrient absorption and utilization—critical factors for optimal egg production (Mehraj *et al.*, 2024).

However, the lack of statistically significant results in egg production following the supplementation of pineapple peel probiotics may be attributed to environmental factors,

particularly elevated temperatures (Setiawati *et al.*, 2016). High ambient temperatures, recorded between 30–34°C at the research site, are known to reduce egg production, as more energy is expended by the birds to regulate body temperature (Rahmawati *et al.*, 2017). Other influencing factors include the age of the birds, strain, type of feed, nutrient composition, and stress levels (Lokapirnasari *et al.*, 2017).

3.1.3 Egg weight

Egg weights across the different treatments in this study were similar, showing no significant variation (Table 1). This aligns with the findings of Xiang *et al.* (2019), who reported that adding probiotics to the diet of laying hens does not significantly affect egg weight. This consistency may be due to the protein content in all feed treatments meeting the standard nutrient requirements. The primary factor influencing egg size is the quality of the feed, particularly its protein content and amino acids, especially methionine (Huda *et al.*, 2019). The quail egg weights in this study, ranging from 9.50 to 10.69 grams, are comparable to those reported by Poli *et al.* (2022) when probiotics were administered in drinking water.

3.1.4 Feed conversion

The calculation of feed conversion is essential to assess the ability of quail to convert consumed feed into egg production. In this study, the average feed conversion ranged from 2.03 to 2.08, with no significant differences observed between treatments ($P > 0.05$). However, there was a tendency for feed conversion to improve as the concentration of probiotics in drinking water increased. The lowest feed conversion was recorded in the P₅ treatment, which included 5% probiotic per liter of drinking water. This improvement can be attributed to an increase in beneficial microbes in the intestine, enhancing nutrient absorption efficiency (Lokapirnasari *et al.*, 2017).

The *Lactobacillus casei* present in pineapple peel probiotics plays a key role in improving feed efficiency by inhibiting the growth of pathogenic bacteria through competition and antibiosis. This strain has demonstrated potential to suppress *Salmonella* growth in the quail's intestinal tract (Hayashi *et al.*, 2018), thereby contributing to a balanced gut microflora. Feed conversion is a critical parameter for evaluating the effectiveness of a treatment, as it directly impacts production costs. Lower feed

conversion values indicate greater efficiency in feed utilization for egg production, leading to more profitable outcomes.

3.2 Egg quality

3.2.1 Fat and cholesterol

The fat and cholesterol content of quail eggs given drinking water supplemented with pineapple peel probiotics is presented in **Table 2**. While the addition of pineapple peel probiotics to quail drinking water reduced the fat and cholesterol content in eggs, the reduction was not statistically significant ($P>0.05$). Nonetheless, there was a trend of decreasing fat and cholesterol levels as the amount of pineapple peel probiotics increased. Several studies have similarly reported that probiotics can lower cholesterol and fat levels in eggs (Ezema and Eze, 2015; Sun *et al.*, 2015; Tang *et al.*, 2016).

Table 2. Average Chemical Composition of Quail Eggs Fed Probiotics

Treatment	Fat (%)	Cholesterol (mg/100 g)
P ₀	47.98	805.54
P ₁	47.60	791.90
P ₂	47.34	775.34
P ₃	47.23	760.46
P ₄	46.91	741.83
P ₅	46.37	715.38

This reduction is attributed to various mechanisms linked to the effects of pineapple peel probiotics on gut microbiota. Pineapple peels are rich in fiber and bioactive compounds, such as vitamin C, *flavonoids*, and *polyphenols*. These compounds promote gastrointestinal health, reduce inflammation, and improve overall metabolic function in poultry by enhancing the growth of beneficial gut bacteria, including *Lactobacillus spp.* and *Bifidobacterium spp.* Pineapple peel probiotics are known to improve gut health and modify lipid metabolism, leading to decreased cholesterol absorption and synthesis in the gastrointestinal tract (Pankhong *et al.*, 2023; Díaz-Vela *et al.*, 2015). This reduction is partly due to the ability of probiotics to deconjugate bile salts, increasing cholesterol excretion and reducing its absorption (Shokryazdan *et al.*, 2017).

Pineapple peels contain pectin, a soluble fiber known for its ability to reduce cholesterol absorption in the gut. When chickens are fed a diet supplemented with pineapple peel probiotics, these pectins can decrease fat absorption in the digestive tract,

leading to lower fat and cholesterol levels in the eggs. The high fiber content of pineapple peel not only serves as a substrate for probiotic bacteria growth but also fosters a healthier gut microbiome, improving nutrient absorption and overall metabolic efficiency (Díaz-Vela *et al.*, 2015). The fermentation of fiber by probiotic bacteria produces short-chain fatty acids (SCFAs), which are linked to improved lipid profiles and reduced fat accumulation in animal tissues (Meena *et al.*, 2021). Additionally, the antioxidant properties in pineapple peel contribute to modulating lipid metabolism and reducing oxidative stress, further influencing cholesterol and fat levels in eggs (Pankhong *et al.*, 2023; Meena *et al.*, 2021). The combined effect of probiotics and the bioactive compounds in pineapple peels creates a favorable environment for reducing fat and cholesterol content in the eggs produced by quail.

4. Conclusion

The addition of pineapple peel probiotics in drinking water has been shown to enhance productivity and reduce the fat and cholesterol content of quail eggs.

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