

Effect of Fermented Dragon Fruit Peel Extract and Fermented Papaya Seeds in Drinking Water on Improving the Growth and Carcass Quality of Free-Range Native Chickens

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Abstract— Free-range native chickens have considerable potential for growth and carcass production. However, their productivity often remains low, mainly due to limitations in feed quality and management practices. One promising approach to address this issue is the use of natural additives in drinking water, particularly those derived from agricultural by-products such as fermented dragon fruit peel and papaya seeds. These materials are rich in bioactive compounds and are environmentally friendly, making them attractive alternatives to synthetic additives. Previous studies have shown that phytobiotics and fermented products can improve nutrient digestibility and utilization in poultry. Nevertheless, information on the use of fermented dragon fruit peel and papaya seed extracts—either individually or in combination—on the growth performance, carcass characteristics, and offal yield of free-range native chickens is still limited. Therefore, this study was conducted to evaluate the effects of these fermented extracts when administered through drinking water. The experiment was arranged in a completely randomized design with four treatments and five replications, involving a total of 200 native chickens reared under a free-range system. The treatments consisted of drinking water without extract (control, T0), drinking water supplemented with 4% fermented dragon fruit peel extract (T1), drinking water supplemented with 4% fermented papaya seed extract (T2), and drinking water containing a combination of 2% fermented dragon fruit peel extract and 2% fermented papaya seed extract (T3). Growth performance parameters observed included final body weight, weight gain, feed intake, and feed conversion ratio, while carcass traits included slaughter weight, carcass weight, carcass percentage, and internal and external offal percentages. Data were analyzed using analysis of variance, followed by Duncan's multiple range test when significant differences were detected. The results showed that supplementation with fermented dragon fruit peel extract, fermented papaya seed extract, or their combination significantly improved final body weight, weight gain, feed conversion ratio, slaughter weight, carcass weight, and carcass percentage compared to the control group. Final body weight ranged from 812.75 g (control) to 920.00 g (combination treatment), while carcass percentage increased from 64.29% (control) to 65.73% (combination treatment). In contrast, feed intake as well as internal and external offal percentages were not affected by the treatments. These findings indicate that fermented dragon fruit peel and papaya seed extracts, administered through drinking water, can be effectively used to enhance growth performance and carcass production of free-range native chickens.

Keywords— Native chickens, fermented dragon fruit peel, fermented papaya seeds, native chicken growth, carcass production.

I. INTRODUCTION

Free-range chickens are local poultry that have high economic value and are sought after by consumers for their distinctive meat flavor. In Bali, free-range chickens play a very important role in religious ceremonies, so many people raise them. The free-range system is widely used by the community because it requires relatively little cost, utilizes the surrounding environment, and is in line with the concept of animal welfare. Challenges often faced by smallholder farmers with this system

include fluctuations in the quality of natural feed, the risk of exposure to pathogens from the environment, and lower production efficiency compared to intensive systems.

Another common problem is that native chickens are susceptible to digestive tract disorders due to exposure to pathogenic microorganisms from soil, water, and the open environment. This condition affects low weight gain, high feed conversion ratios, and unstable production performance. The use of drugs and antibiotic growth promoters (AGPs) is increasingly restricted due to issues of residue and antimicrobial resistance, so safe and sustainable natural alternatives are needed (Makkar, 2016).

The use of plant-based natural ingredients (phytogenic) is a potential alternative for improving poultry health and performance. Dragon fruit peel and papaya seeds are abundant agricultural waste products that have not been optimally utilized. Dragon fruit peel and papaya seeds contain bioactive compounds such as antioxidants (flavonoids, phenolics), natural antibacterial compounds, and prebiotic components that have the potential to support intestinal microflora. Dragon fruit peel is rich in phytoalbumins, which act as natural antioxidants (Dewi et al., 2022). In addition, every 100 g of dragon fruit peel contains about 60 calories, consisting of unsaturated fats, proteins, and carbohydrates, thus potentially supporting livestock energy and metabolic needs (Dewi et al., 2022). Papaya seeds have several chemical compounds that can inhibit bacteria, such as flavonoids, saponins, tannins, and alkaloids. Papaya seeds are known to contain protein, oil, and bioactive compounds such as papain and flavonoids that function as phytogenic agents to improve digestive health and growth efficiency in chickens (Dissa et al., 2023). The utilization of this waste is in line with the principles of green agro-industry and circular economy.

Fermentation of dragon fruit peel and papaya seeds is necessary to reduce antinutrients, increase nutrient availability, produce beneficial metabolites (organic acids, enzymes, probiotic microbes), and improve digestibility and digestive health in poultry. Fermentation is an effective method for improving the quality of feed ingredients from complex to simple. Fermentation can reduce antinutrient levels, improve digestibility, and enrich the probiotic content in feed ingredients (Xu et al., 2023). Several studies have shown that the use of fermented ingredients in poultry rations can improve growth performance and maintain intestinal microbiota balance. Other studies also report that providing drinking water containing fermented dragon fruit peel can increase body weight and feed efficiency in local chickens and quails (Dewi et al., 2022). Providing fermentation products through drinking water is considered more practical in free-range farming systems compared to mixing them into feed, and it allows for more even consumption among livestock.

Several studies have reported the use of fermented dragon fruit peel and papaya seeds separately in poultry. However, studies on the combination of these two ingredients in fermented form and their application through drinking water in free-range native chickens are still very limited. In addition, the interaction between free-range farming systems and the administration of natural probiotics based on agricultural waste has not been widely explored.

Based on this, a study was conducted to examine the effect of the combination of fermented dragon fruit peel and papaya seeds in drinking water and to evaluate its impact on the performance, carcass production, internal and external offal of free-range chickens, as well as to provide a cheap, environmentally friendly, and applicable natural feed additive alternative for smallholder farmers.

II. MATERIAL AND METHODS

This study used 200 native chickens aged 4 weeks to 18 weeks. The materials used in this study included samples of red dragon fruit (*Hylocereus* sp.) peel and ripe papaya seeds as sources of fermented material. Probiotics were produced using EM4 and molasses as fermenters for dragon fruit peel and papaya seeds.

The study was conducted through free-range cage management (10 chickens per 5 × 5 m pen) given probiotics based on red dragon fruit peel and papaya seed waste in the drinking water of native chickens aged 12-18 weeks. The treatments given were:

- T0: Drinking water without extract (control)
- T1: Drinking water with 4% fermented dragon fruit peel extract
- T2: Drinking water with 4% fermented papaya seed extract
- T3: Drinking water with a mixture of 2% fermented dragon fruit peel extract and 2% fermented papaya seed extract

The study was conducted using a completely randomized design (CRD) with 4 treatments and 5 replicates, where each replicate consisted of 10 animals.

The variables observed were: final body weight, weight gain, feed consumption, FCR, slaughter weight, carcass weight, carcass percentage, external offal percentage, and internal offal percentage.

- **Slaughter weight** is obtained by weighing live chickens immediately before slaughter, after the chickens have been fasted for ± 8–12 hours.
- **Carcass weight** is obtained by weighing the chicken carcass after slaughter, bleeding, plucking, cutting off the head and feet, and removing all internal organs.
- **Carcass percentage** is obtained by comparing the carcass weight with the slaughter weight multiplied by 100%.
- **Internal offal percentage** is obtained by comparing the weight of the internal offal (heart, liver, spleen, digestive tract) with the slaughter weight multiplied by 100%.
- **External offal percentage** is obtained by comparing the weight of the external offal (head, neck, feathers, and feet) with the slaughter weight multiplied by 100%.

The data obtained were analyzed using analysis of variance. If a significant difference was found between treatments ($P < 0.05$), the analysis was continued using Duncan's multiple range test (Steel & Torrie, 1993).

III. RESULTS AND DISCUSSION

TABLE 1

GROWTH AND PRODUCTION OF 4-18 WEEK OLD NATIVE CHICKENS REARED USING A FREE-RANGE SYSTEM

Variable	T0	T1	T2	T3	SEM
Final body weight (g)	812.75b	850.00ab	890.00a	920.00a	10.24
Body weight gain (g)	593.45b	630.00ab	670.90a	701.00a	6.33
Feed consumption (g)	2600.70a	2590.00a	2630.00a	2700.00a	6.33
FCR	4.21b	4.11ab	3.92a	3.85a	0.08
Slaughter weight (g)	812.00b	835.00a	870.00a	890.00a	31.28
Carcass weight (g)	522.00b	540.00ab	565.00a	585.00a	26.4
Carcass (%)	64.29b	64.67b	64.94b	65.73a	0.6
Internal offal (%)	22.75a	19.96a	19.18a	19.15a	0.76
External offal (%)	25.60a	24.72a	23.47a	22.50a	0.89

Note:

- T0: Drinking water without extract (control)
- T1: Drinking water with 4% fermented dragon fruit peel extract
- T2: Drinking water with 4% fermented papaya seed extract
- T3: Drinking water with 2% fermented dragon fruit peel extract and 2% fermented papaya seed extract
- Values with the same superscript letter in the same row are not significantly different ($P > 0.05$)
- SEM: Standard Error of the Treatment Means

3.1 Growth Performance:

The final body weight of native chickens in treatments T0, T1, T2, and T3 was 812.75 g, 850.00 g, 890.00 g, and 920.00 g, respectively, with the highest body weight in treatment T3 (combination of 2% dragon fruit peel extract and 2% fermented papaya seed extract). Treatment T3 showed a statistically significant difference ($P < 0.05$) compared to treatment T0. Treatment T1 was 4.03% higher than T0 but not significantly different ($P > 0.05$), while T2 and T3 were 8.68% and 11.66% higher, respectively, and were significantly different ($P < 0.05$) from T0. Treatments T2 and T3 were 4.49% and 7.61% higher than T1, but these differences were not statistically significant ($P > 0.05$).

During the study, there was no significant difference ($P > 0.05$) in feed consumption between treatments T0, T1, T2, and T3, which were 2600.70 g, 2590.00 g, 2630.00 g, and 2700.00 g per bird, respectively. This indicates that the treatments did not affect the amount of feed consumed, suggesting that the improvements in growth were due to better nutrient utilization rather than increased intake.

The weight gain in treatments T2 and T3 was higher by 11.54% and 15.34%, respectively, compared to treatment T0, and these differences were statistically significant ($P < 0.05$). Treatment T1 showed a 6.10% increase in weight gain compared to T0, but this difference was not statistically significant ($P > 0.05$).

The feed conversion ratio (FCR) in treatments T2 and T3 was significantly lower by 6.99% and 8.55%, respectively, compared to treatment T0 ($P < 0.05$), indicating better feed efficiency. Treatment T1 had an FCR that was 2.38% lower than T0, but this difference was not statistically significant ($P > 0.05$).

These improvements can be attributed to the bioactive compounds present in the fermented extracts. Dragon fruit peel is rich in anthocyanins and phenolic compounds that act as antioxidants, thereby boosting the immune system of native chickens (Putri et al., 2022). Furthermore, the nutrients in the feed consumed are digested and absorbed more efficiently, which can be used to increase body weight and carcass percentage. According to Mesquita et al. (2023), papaya seeds are rich in crude protein, fat, and phenolic compounds and flavonoids that act as natural antioxidants. In addition, the papain and carpain content in papaya seeds also acts as natural antimicrobial and enzymatic digestive agents that can help the feed metabolism process in poultry (Dissa et al., 2023).

The administration of papaya seeds, both in dried and fermented forms, has been proven to improve growth, feed efficiency, and digestive health in native chickens. This is because bioactive compounds from natural sources are known to influence the composition of gut microbiota by suppressing the growth of pathogenic bacteria and increasing the population of beneficial microbes such as *Lactobacillus* and *Bifidobacterium*, thereby helping to maintain microbiota balance and digestive health (Cano, 2024).

Probiotics added to animal feed or drinking water can modulate the gastrointestinal microbiota, suppress the growth of pathogenic bacteria, and support the colonization of beneficial microbes that contribute to animal intestinal health (Gaggia et al., 2010). Probiotics can suppress the growth of pathogenic microbes, thereby improving digestive tract health and leading to better nutrient absorption. Therefore, feeding native chickens fermented dragon fruit peel mixed with papaya seeds can improve their digestive tract health, resulting in better nutrient absorption. This results in a reduction in nutrients such as fat, protein, and carbohydrates that are typically lost in feces.

This is supported by the increase in the body weight of native chickens observed in treatment T3, which was given drinking water supplemented with 2% fermented dragon fruit peel extract and 2% fermented papaya seeds, showing the highest body weight compared to other treatments. In terms of FCR, all treatments with the addition of fermented dragon fruit peel and fermented papaya seeds showed a lower FCR compared to the control treatment. This is thought to be due to the presence of beneficial microbes in the digestive tract of native chickens, which increase nutrient absorption. Yuanita et al. (2022) showed that adding dragon fruit peel extract or fermentation to the drinking water of local chickens can increase body weight and feed efficiency, as well as improve intestinal microflora conditions.

3.2 Carcass Characteristics:

Table 1 shows the effect of treatment on slaughter weight, carcass weight, and carcass percentage of native chickens. For slaughter weight, treatments T1, T2, and T3 were 2.75%, 6.67%, and 8.76% higher, respectively, and were significantly different ($P < 0.05$) from T0. The slaughter weight of native chickens in treatments T2 and T3 was higher by 4.02% and 6.18%, respectively, compared to T1, but these differences were not statistically significant ($P > 0.05$).

The average carcass weight in treatments T1, T2, and T3 was higher by 3.33%, 7.08%, and 10.76%, respectively, and were significantly different ($P < 0.05$) compared to T0. Between treatments T2 and T3, carcass weight was higher by 4.63% and 7.69%, respectively, compared to T1, but these differences were not statistically significant ($P > 0.05$).

The average carcass percentage of native chickens was highest in treatment T3 (drinking water supplemented with a mixture of 2% dragon fruit peel extract and 2% papaya seed extract), which was 2.19%, 1.61%, and 1.20% higher than treatments T0, T1, and T2, respectively, and these differences were statistically significant ($P < 0.05$). This improvement is attributed to the fermentation process of dragon fruit peel and papaya seeds. Dragon fruit peel is rich in anthocyanins and phenolic compounds that act as antioxidants, thereby boosting the immune system of native chickens. Furthermore, the nutrients in the feed consumed are digested and absorbed well, which can be used to increase the weight and percentage of native chicken carcasses and carcass parts, including the breast, back, thighs, and wings.

Bidura et al. (2012) and Dewi et al. (2022) stated that the fermentation process breaks down proteins and carbohydrates into amino acids, nitrogen, and dissolved carbon, which are necessary for protein synthesis. Thus, fermentation can increase the

nutrients absorbed by poultry, which will result in increased carcass weight. Dewi et al. (2022) found that 4–6% fermented dragon fruit peel juice in drinking water can increase carcass weight and breast percentage in 6–11-week-old male native chickens. Dragon fruit peel constitutes approximately 22–30% of the total fruit weight and is rich in anthocyanins and phenolic compounds that act as antioxidants (Le, 2022).

3.3 Offal Percentages:

The internal offal percentages (heart, liver, spleen, digestive tract) ranged from 19.15% to 22.75% across treatments, with no significant differences ($P>0.05$) observed among treatments. Similarly, external offal percentages (head, neck, feathers, feet) ranged from 22.50% to 25.60%, with no significant differences ($P>0.05$) among treatments. This indicates that the supplementation of fermented extracts specifically targeted improvements in carcass components rather than affecting offal proportions.

IV. CONCLUSION

Based on the results of this study, it can be concluded that the use of agricultural waste in the form of fermented dragon fruit peel extract and fermented papaya seed extract in drinking water is a potential natural feed innovation in free-range native chicken farming. The bioactive compounds, antioxidants, and phytochemical substances in both materials, especially after fermentation, can support improvements in the quality of free-range chicken carcasses.

The administration of fermented dragon fruit peel extract (T1), fermented papaya seed extract (T2), and their combination (T3) has been proven to have a significant effect on final body weight, weight gain, feed conversion ratio, slaughter weight, carcass weight, and carcass percentage of free-range chickens compared to the control treatment (T0). The combination treatment (T3) produced the highest final body weight (920.00 g), best feed conversion ratio (3.85), and highest carcass percentage (65.73%). However, the treatments did not significantly affect feed intake or the percentages of internal and external offal. This indicates that the treatments play a greater role in improving nutrient utilization efficiency and body tissue distribution than in increasing overall feed consumption.

The use of a free-range rearing system combined with fermented natural additives is in line with the concept of animal welfare and supports sustainable and environmentally friendly livestock production. Therefore, fermented dragon fruit peel extract and fermented papaya seed extract, particularly in combination, can be recommended as natural supplement alternatives through drinking water to improve the growth performance and carcass quality of free-range native chickens without negatively impacting offal.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this research. The materials used in this study, including fermented dragon fruit peel extract and fermented papaya seed extract, were prepared independently by the researchers and were not influenced by any commercial or financial interests.

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