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Economic feasibility and cost-effectiveness of fermented rice wash based supplementation in broiler production

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ABSTRACT

This study evaluated fermented rice washing as a locally available supplement to improve growth performance and economic returns in broiler production. We randomly assigned twenty-five-day-old broilers to five treatments using a Completely Randomized Design, with five birds per treatment. Treatments consisted of plain water (T1), commercial organic supplement (T2), and fermented rice washing at 5% (T3), 10% (T4), and 15% (T5). The feeding trial lasted 35 days. We evaluated final weight, weight gain, feed intake, feed conversion ratio (FCR), water intake, production cost, gross income, net income, and return on investment (ROI). We analyzed the data using analysis of variance. Final weight, weight gain, feed intake, water intake, gross income, net income, and ROI differed significantly ($p<0.05$), while FCR and production cost did not. T2 recorded the highest final weight (1.75 kg), weight gain (1.703 kg), gross income (₱262.18), net income (₱92.19), and ROI (54.27%). However, T4 (10% fermented rice washing) produced comparable final weight (1.71 kg), weight gain (1.664 kg), net income (₱87.27), and ROI (51.45%) to T2. Fermented rice washing, particularly at 10%, showed potential as a practical supplementation level for broilers, providing favorable growth performance and economic returns without significantly increasing production costs.

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INTRODUCTION

Broiler production provides an important source of income and affordable animal protein; however, rising feed costs and dependence on commercial growth-promoting supplements often constrain its profitability (Rafiq *et al.*, 2022; Al-Seraih *et al.*, 2022). Growing concerns about antimicrobial resistance have also encouraged the poultry industry to explore natural, locally available alternatives that may improve feed utilization without relying on antibiotic growth promoters (Abd El-Hack *et al.*, 2020; Ahmad *et al.*, 2022). Although commercial probiotics can support broiler performance, their cost may limit their use among small-scale producers (Al-Seraih *et al.*, 2022).

Rice-washing water is an abundant household by-product containing residual starch and other nutrients that may support fermentation (Nabayi *et al.*, 2022). When combined with fermentable substrates, it can be developed into a low-cost fermented preparation for poultry supplementation (Astuti *et al.*, 2022). Researchers have studied fermented products for their potential effects on growth, nutrient digestibility, and feed efficiency in poultry (Nopparatmaitree *et al.*, 2026; Zhang *et al.*, 2022). However, limited information is available on their economic value under small-scale broiler production conditions. Therefore, evaluating production costs and financial returns is necessary before recommending their practical adoption.

This study evaluated the economic feasibility of supplementing broiler drinking water with different levels of a fermented rice-wash-based preparation. Specifically, it compared production costs, gross income, net return, and return on investment among broilers receiving plain water, a commercial supplement, and 5%, 10%, or 15% fermented rice-wash-based supplementation. The study aimed to identify the inclusion level that best balanced production performance and economic return.

MATERIALS AND METHODS

Ethical considerations

The birds were managed in accordance with the Philippine Animal Welfare Act and applicable institutional guidelines for the care and use of experimental animals. The study protocol was approved by the Institutional Animal Care and Use Committee (IACUC) of Matias H. Aznar Memorial College of Medicine, Inc.

Experimental design and treatments

The study was conducted at the Cebu Technological University Moalboal Research Facility. A total of 25-day-old broiler chicks sourced from a local agri-veterinary store in Moalboal, Cebu, were randomly assigned to five treatments using a Completely Randomized Design (CRD), with five birds per treatment. The experimental treatments consisted of plain drinking water as the negative control (T-), a commercial organic supplement as the positive control (T+), and a fermented rice-wash-based preparation administered at 5% (T3), 10% (T4), and 15% (T5) inclusion levels in drinking water. The feeding trial lasted for 35 days. All experimental birds received a uniform commercial broiler diet and had ad libitum access to feed and drinking water throughout the study.

Preparation of the fermented rice wash

The Food Innovations Laboratory of Cebu Technological University (CTU) Moalboal Campus developed and processed the fermented preparation. Fresh rice-washing water was collected in clean containers and allowed to undergo an initial aerobic/ambient fermentation for three days. After this phase, molasses and soy milk were added to the fermented rice wash at a 1:1:1 volumetric ratio. The mixture was transferred to sterilized glass containers, secured with breathable cheesecloth, and kept at room temperature away from direct sunlight for three weeks to complete fermentation. Upon completion of the fermentation period, the liquid preparation was strained through a fine filter, decanted into sterile, airtight storage bottles, and stored at 4–5°C until administration

Production data collection

Recorded feed offered and feed refusals to determine total feed consumption. We measured water offered

and the remaining volume every 24 hours. We recorded individual body weights at the beginning and end of the experiment. Body-weight gain and feed conversion ratio were calculated using the following equations:

Body-weight gain = Final weight - Initial weight

FCR = Total feed consumed / Total body-weight gain

Mortality, when present, was recorded and considered in the calculation of production and economic outcomes.

Economic analysis

Evaluated economic performance using prevailing input and live-bird prices during the experimental period. Variable expenses included chicks, feed, commercial supplement, molasses, soy milk, labor, electricity, water, medication, and other production inputs. We excluded costs associated with cages and reusable equipment or allocated them through depreciation.

Calculated gross income by multiplying saleable live weight by the prevailing farm-gate price per kilogram. Net return, return on investment, benefit-cost ratio, and cost per kilogram of weight gain were calculated as follows:

Gross income = Saleable live weight x Farm-gate price
Net return = Gross income - Total production cost
ROI (%) = (Net return / Total production cost) × 100
Benefit-cost ratio = Gross income / Total production cost
Cost per kg gain = Total production cost / Total body-weight gain

Used a partial-budget analysis to determine the additional costs and benefits of replacing the commercial supplement with the fermented preparation. If complete cost records are available, sensitivity analysis should also be performed by adjusting feed and live-bird prices by +/-10% and +/-20%.

Statistical analysis

Production and economic data were analyzed using one-way analysis of variance. When significant treatment effects were detected, treatment means were compared using an appropriate post-hoc test at a 5% significance level. Results should be presented as means with their corresponding standard errors and exact p-values. Statistical analysis was conducted using

RESULTS AND DISCUSSION

Growth performance of broiler chicken supplemented with fermented rice washed

Average final weight

The results showed a significant difference in the final weight of broilers among the treatments ($p = 0.0001$). T2, which received the commercial organic supplement, had the highest final weight at 1.75 kg, followed by T4 with 10% fermented rice washing at 1.71 kg, T5 at 1.66 kg, T3 at 1.62 kg, and T1 with plain water at 1.57 kg. T2 and T4 were found to be similar based on the statistical grouping. This means that although T2 had the highest final weight, the broilers given 10% fermented rice washing achieved a comparable result. The better performance of T4 compared with T3 and T5 also suggests that 10% fermented rice washing provided a more favorable level for supporting broiler growth. Overall, T2 had the highest final weight, while T4 showed the most promising result among the fermented rice washing treatments (Table 1).

This finding is supported by Salvedia and Libres (2018), who reported improved growth performance among broilers supplemented with rice-washed water probiotic drinks. Their findings showed that rice-washed water containing beneficial microorganisms could contribute to improved weight gain compared with birds that did not receive the supplement. Similarly, Gil de los Santos *et al.* (2018) reported that a probiotic produced using parboiled rice effluent improved weight gain in broiler chickens, demonstrating the potential of rice-based materials to support poultry growth. These findings are also consistent with Hossain *et al.* (2025), who found that

probiotic supplementation through drinking water improved final body weight and weight gain in broilers compared with an unsupplemented group. The possible benefit of fermentation may be related to the improvement of the material during the fermentation process, making nutrients more available and providing beneficial microorganisms that may support digestion and nutrient use. Studies involving fermented rice-based feeds have likewise reported improvements in broiler growth, although responses have not always been consistent. Astuti *et al.* (2022) found no significant improvement in final body weight or weight gain when broilers were given a Lactobacillus casei-fermented mixture of red rice and aromatic ginger. This difference suggests that the effect of fermented products may depend on the type of material used, the amount provided, the microorganisms involved, and how the supplement is given to the birds. In the present study, the increase from 5% to 10% fermented rice washing resulted in better final weight, while the 15% treatment did not provide a further improvement. This suggests that providing more of the fermented material does not necessarily result in greater growth.

Table 1. Growth performance of broiler chicken supplement with rice wash

Treatment	Average final weight (kg)	Average weight gained (kg)	Average feed intake (kg)	Feed conversion ratio	Average water intake (litter)
T1- Negative control (plain water)	1.57^{d}	1.530^{d}	2.782^{d}	1.88	5.629^{d}
T2- Positive control (commercial organic supplement)	1.75^{a}	1.703^{a}	2.991^{a}	1.76	6.187^{a}
T3- 5% Fermented rice washed	1.62^{c}	1.582^{cd}	2.918^{c}	1.85	5.797^{cd}
T4- 10% Fermented rice washed	1.71^{ab}	1.664^{ab}	2.956^{b}	1.77	6.098^{bc}
T5- 15% Fermented rice washed	1.66^{bc}	1.615^{bc}	2.925^{bc}	1.81	5.929^{bc}
P-value	0.0001	0.0001	0.0000	0.0553	0.0001
CV (%)	2.83	2.89	0.90	3.75	2.54

Average weight gained

A significant difference was also observed in the weight gained by the broilers (p = 0.0001). T2 recorded the highest average weight gain at 1.703 kg, followed by T4 at 1.664 kg, T5 at 1.615 kg, T3 at 1.582 kg, and T1 at 1.530 kg. T2 and T4 were statistically similar, showing that the broilers receiving 10% fermented rice washing gained nearly the same amount of weight as those receiving the commercial organic supplement. The results also show that increasing fermented rice washing from 5% to 10% improved weight gain, but increasing it further to 15% did not provide an additional increase. Therefore, T2 had the highest weight gain, while T4 was the best-performing fermented rice washing treatment. This finding suggests that 10% fermented rice washing may be a suitable level for supporting broiler growth.

This finding is supported by Salvedia and Libres (2018), who reported improved weight gain in broilers supplemented with rice washing water probiotic drinks, suggesting that fermented rice washing can provide beneficial microorganisms that support growth. Similarly, Ullah *et al.* (2021) found that broilers fed fermented rice bran showed improved weight gain, with the 10% fermented rice bran treatment producing the highest gain among the levels tested, which is consistent with the present finding that 10% fermented rice washing produced the highest weight gain among the fermented treatments. The results are also supported by Šimunović *et al.* (2022), who reported increased weight gain in broilers receiving Bacillus subtilis through drinking water, and by Zhang *et al.* (2022), who found that selected *Lactobacillus* reuteri-based drinking-water treatments improved body weight and average daily gain. Hossain *et al.* (2025) likewise reported that probiotic supplementation through drinking water increased body weight and weight gain compared with the untreated control. These studies support the possibility that beneficial microorganisms and fermentation-derived components provided through water can contribute to improved growth and nutrient utilization in broilers.

However, Astuti *et al.* (2022) reported no significant improvement in final body weight and weight gain when broilers were supplemented with a Lactobacillus casei-fermented mixture, indicating that the response to fermented products may vary according to the material used, microorganism involved, supplementation level, and fermentation process. Overall, the present findings suggest that 10% fermented rice washing may be a suitable level for supporting broiler growth because it produced a weight gain statistically comparable with the commercial organic supplement, while increasing the level to 15% did not result in further improvement.

Average feed intake

The average water intake of broilers differed significantly among treatments ($p = 0.0001$), with T2 recording the highest intake at 6.187 L, followed by T4 at 6.098 L, T5 at 5.929 L, T3 at 5.797 L, and T1 at 5.629 L. Among the fermented rice-washing treatments, T4 (10%) recorded the highest water intake. This finding is supported by Rahmatillah, Firdus, and Allaily (2025), who evaluated fermented beverages and probiotics administered through drinking water and reported measurable differences in water intake among treatments. Similarly, Li *et al.* (2022) found that supplementation of drinking water with an acidifier increased water consumption at certain inclusion levels. These findings suggest that the composition of supplemented drinking water may influence voluntary water consumption in broilers. However, the present study did not directly determine the specific factors responsible for the differences in water intake. Overall, the higher water intake observed in T4 indicates that 10% fermented rice washing was well accepted by the birds and may be a suitable level for supplementation through drinking water.

Average feed conversion ratio

The feed conversion ratio (FCR) did not differ significantly among treatments ($p = 0.0553$). Numerically, T2 had the lowest FCR at 1.76, followed closely by T4 at 1.77, T5 at 1.81, T3 at 1.85, and T1 at 1.88, indicating that T2 and T4 had slightly better feed utilization. This finding agrees with studies reporting that fermented or probiotic supplementation does not always significantly improve FCR. Hossain *et al.* (2025) reported nonsignificant differences in FCR among selected supplemented treatments, while recent research on fermented rice bran also found no significant difference in overall FCR. In contrast, Ullah *et al.* (2021) reported improved FCR in broilers given 10% fermented rice bran, indicating that responses may vary according to the fermented material, supplementation level, and experimental conditions. Therefore, although T4 (10% fermented rice washing) showed a numerically favorable FCR close to the commercial supplement, the present results do not provide sufficient statistical evidence that fermented rice washing improved feed efficiency.in some treatments cannot be attributed to a significant improvement in feed conversion.

Average water intake

The treatments also resulted in significant differences in water intake ($p = 0.0001$). T2 had the highest average water intake at 6.187 L, followed by T4 at 6.098 L, T5 at 5.929 L, T3 at 5.797 L, and T1 at 5.629 L. The birds receiving the commercial organic supplement consumed the most water, while those receiving 10% fermented rice washing had the second-highest water intake. The higher water consumption in these treatments was also accompanied by higher feed intake and better growth results. This suggests that the supplemented birds maintained good feed and water consumption throughout the study. T2 had the highest water intake, while T4 again showed the strongest performance among the fermented rice washing treatments. Overall, the results indicate that providing supplementation was associated with greater water consumption compared with plain water alone.

This finding agrees with Guo *et al.* (2022), who reported that broilers receiving supplemented drinking water had increased water consumption at certain inclusion levels. Similarly, a study on acidified

drinking water reported significantly higher water consumption among supplemented broilers than the control, indicating that changes in drinking-water composition can influence voluntary water intake. Rahmatillah *et al.* (2025) also observed differences in water intake among broilers provided with fermented and probiotic supplements through drinking water. These findings support the present observation that supplemented birds consumed more water than those receiving plain water. The higher water intake in T2 and T4 was also accompanied by greater feed intake and improved growth performance, suggesting that these treatments supported active feed and water consumption during the experimental period. However, the present study did not directly determine whether palatability or specific changes in the fermented rice-washing solution were responsible for the increased water consumption. Overall, 10% fermented rice washing showed the most favorable water-intake response among the fermented treatments.

Economic performance and profitability of fermented rice wash-based supplementation

Production cost

The production cost did not differ significantly among the treatments (p = 0.89). T2 had the highest production cost at ₱169.98, followed by T3 at ₱170.68, T1 at ₱172.52, T4 at ₱169.71, and T5 at ₱169.55. Although there were small differences in the amount spent to raise the broilers, these differences were not large enough to be considered meaningful. The relatively similar production costs across treatments indicate that adding fermented rice washing did not substantially increase the overall cost of production. In particular, T4 and T5 had slightly lower costs than the commercial supplement and plain-water treatment. The similar production costs suggest that fermented rice washing can be included in broiler production without causing a noticeable increase in expenses. This is important because a supplement becomes more useful to farmers when it can be used without adding considerable production costs.

Table 2. Economic performance of feed

Treatment	Production cost (₱)	Gross income (₱)	Net income (₱)	ROI (%)
T1- Negative control (plain water)	172.52	235.52^{d}	63.00^{d}	35.55^{d}
T2- Positive control (commercial organic supplement)	169.98	262.18^{a}	92.19^{a}	54.27^{a}
T3- 5% Fermented rice washed	170.68	243.57^{cd}	72.89^{c}	42.72^{c}
T4- 10% Fermented rice washed	169.71	256.98^{ab}	87.27^{a}	51.45^{a}
T5- 15% Fermented rice washed	169.55	248.61^{bc}	79.07^{b}	46.66^{b}
P-value	0.89	0.0001	0.000	0.0000
CV (%)	3.04	2.83	5.62	6.11

Gross income

Gross income differed significantly among the treatments (p = 0.0001). T2 generated the highest gross income at ₱262.18, followed by T4 at ₱256.98, T5 at ₱248.61, T3 at ₱243.57, and T1 at ₱235.52. The high gross income obtained by T2 was consistent with its higher production performance, particularly its higher final body weight. T4 also produced a high gross income and was statistically comparable with T2, showing that broilers given 10% fermented rice washing generated a similar level of sales income to those receiving the commercial organic supplement. The lower gross income in T1 reflects the comparatively lower production performance of birds receiving plain water. The results indicate that supplementation increased the amount of income generated from broiler production. More importantly, 10% fermented rice washing produced a gross income close to that of the commercial supplement, suggesting that it may be a practical option when a commercial supplement is costly or less accessible (Table 2).

Net income

A significant difference was observed in net income among the treatments (p = 0.000). T2 obtained the highest net income at ₱92.19, followed by T4 at ₱87.27, T5 at ₱79.07, T3 at ₱72.89, and T1 at

₱63.00. Since net income represents the amount remaining after production expenses have been deducted from the income generated, the results show that T2 provided the greatest monetary return. However, T4 was statistically comparable with T2 and produced a net income only slightly lower than the commercial supplement. The increasing net income from T3 to T4 suggests that raising fermented rice washing from 5% to 10% improved the financial return. The lower net income at 15% indicates that increasing the level beyond 10% did not provide an additional financial advantage. The results suggest that 10% fermented rice washing can provide a level of net income comparable with the commercial organic supplement. This is particularly relevant for small-scale producers because fermented rice washing may be prepared from readily available materials, potentially providing an accessible way of improving income while keeping production expenses relatively similar.

Return on investment (ROI)

The return on investment differed significantly among treatments ($p = 0.0000$). T2 recorded the highest ROI at 54.27%, followed by T4 at 51.45%, T5 at 46.66%, T3 at 42.72%, and T1 at 35.55%. The higher ROI of T2 indicates that the commercial organic supplement generated the greatest return relative to the money spent on production. However, T4 produced an ROI that was close to that of T2 and was statistically comparable with it. The results also show an improvement in ROI from 5% to 10% fermented rice washing, while the 15% treatment resulted in a lower ROI than the 10% treatment. The findings indicate that T2 had the highest ROI, while T4 provided the strongest economic result among the fermented rice washing treatments. The relatively small difference between T2 (54.27%) and T4 (51.45%) suggests that 10% fermented rice washing may offer a financially competitive alternative to the commercial supplement under the conditions of the study. The lower ROI at 15% further suggests that using a higher level of fermented rice washing does not necessarily lead to greater financial returns.

Overall economic interpretation

Across the economic measures, T2 consistently recorded the highest gross income, net income, and ROI, while production costs were statistically similar among all treatments. Among the fermented rice washing treatments, T4 (10%) consistently produced the highest economic values, with ₱256.98 gross income, ₱87.27 net income, and 51.45% ROI. Its economic performance was statistically comparable with T2 for net income and ROI. These results suggest that 10% fermented rice washing was the most promising level among the fermented rice washing treatments, as it generated higher returns than the 5% and 15% treatments without significantly increasing production costs. Thus, the findings provide practical evidence that fermented rice washing, particularly at 10%, has potential as an alternative supplementation practice for broiler production, subject to the availability and preparation cost of the material under actual farm conditions.

Conclusion

Fermented rice washing significantly affected the growth and economic performance of broilers, while feed conversion ratio and production cost were not significantly affected. The 10% fermented rice washing (T4) produced growth and profitability comparable with the commercial supplement, showing potential as a practical supplementation level for broiler production.

RECOMMENDATION(S)

The use of 10% fermented rice washing is recommended based on its favorable growth and economic performance. Further studies should determine its pH, acidity, proximate composition, mineral content, organic acids, beneficial microorganisms, phytochemical compounds, antioxidant activity, microbial safety, and shelf life, and evaluate its performance under actual farm conditions.

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