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Bioconversion of Oyster Mushroom By-Products into Poultry Feed

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ABSTRACT

Conventional poultry feeds face challenges of cost volatility and nutritional limitations, driving the need for sustainable alternatives. This study was conducted to determine the conversion of oyster mushroom (Pleurotus ostreatus) by-products into a fermented liquid supplement for broilers. The by-products were anaerobically fermented with muscovado sugar (1:1 ratio) for 7 days. Sixty broilers were assigned to one of four drinking water treatments over a 35-day period: 0 mL/L (control), 20 mL/L, 30 mL/L, or 40 mL/L of the fermented oyster mushroom supplement. The feed conversion ratio (FCR) was achieved at 30 mL/L, showing a 16% improvement compared to controls (1.13 vs. 1.34). Increased weight gain occurred at 40 mL/L (1.00 kg vs. 0.87 kg control). While the 20 mL/L group exhibited the highest feed intake (1.43 kg), it resulted in the poorest FCR (1.58). These results indicate that moderate supplementation with the fermented oyster mushroom by-product enhances nutrient bioavailability without compromising growth performance. This approach offers small-scale farmers a low-cost strategy to reduce dependence on conventional feeds while valorizing agricultural waste.

Keywords: Broiler chickens, Fermented Oyster Mushroom, Growth performance, Poultry nutrition, Agricultural waste

INTRODUCTION

The poultry industry is vital to global food security, providing affordable, high-quality protein primarily through broiler chickens (*Gallus gallus domesticus*). However, its sustainability is threatened by rising feed costs—accounting for 60–70% of production expenses and environmental concerns linked to conventional feed resources (Mottet & Tempio, 2017; Van Huis & Oonincx, 2021). These challenges are particularly acute in developing regions like the Philippines, where small-scale farmers face market volatility and disease risks (Ritchie et al., 2022). To address these issues, agro-industrial by-products offer promising low-cost and eco-friendly alternatives for poultry nutrition sustainability (Makkar, 2018; Salazar et al., 2021).

Oyster mushroom (*Pleurotus ostreatus*) cultivation generates significant post-harvest substrate residues. These lignocellulosic materials are rich in fiber, residual proteins, and bioactive compounds with documented health-promoting and growth-enhancing properties in livestock (Bhat et al., 2023; Valverde et al., 2020). Recent advances in fermentation technology, particularly solid-state fermentation offer a potent means to valorize Oyster Mushroom by-products. Solid state Fermentation enhances nutrient bioavailability by degrading indigestible fibers and anti-nutritional factors, while enriching the substrate with microbial proteins, vitamins, enzymes, and beneficial metabolites (Bhagwat et al., 2021; Olukomaiya et al., 2020). Studies demonstrate fermented plant materials significantly improve nutrient digestibility in poultry (Jazi et al., 2018; Sugiharto, 2019), and fermented spent mushroom substrates enhance growth in ruminants (Kumari et al., 2022; Zhang et al., 2020).

Despite this potential, critical research gaps hinder the application of fermented Oyster Mushroom by-products specifically within broiler production systems. Existing research predominantly focuses on solid fermented feed additives or applications in non-poultry species (Saeed et al., 2023; Tufarelli et al., 2018). There is a conspicuous lack of empirical evidence evaluating liquid fermented supplements derived from Oyster Mushroom by-products for broilers.

METHODOLOGY

This study was laid-out in a Completely Randomized Design (CRD) to evaluate the effects of fermented oyster mushroom by-product supplementation on broiler chickens. Sixty heads of one-day-old Cobb 500 broiler chicks were procured from a certified hatchery. Birds were housed in standardized brooding and rearing pens (1.5 m^2 per replicate) with ad libitum access to water and commercial broiler feed randomly allocated into four treatment groups: a control group (pure water) and three experimental groups receiving 20, 30, or 40 mL of Fermented Oyster Mushroom By-product per liter of drinking water. Each treatment was replicated three times, with five birds per replicate. The trial spanned for 35 days, divided into three feeding phases: booster (days 1–12), starter (days 13–22), and finisher (days 23–35). Feed intake and body weight were recorded at 07:00 daily and weekly, respectively. Data were analyzed using one-way ANOVA in SPSS v26.0 compared treatment means, justified by normally distributed data and homogeneity of variance. Post-hoc LSD testing (*p* < 0.05) identified significant differences between doses.

Ethical Considerations

This research study followed ethical guidelines. Animal welfare protocols ensured humane handling, continuous access to feed/water, and daily health monitoring. The birds were monitored until the end of the growth period, and no adverse effects were noted, ensuring the health and safety of the animals throughout the study.

RESULTS AND DISCUSSION

Feed Consumption (kg) of Broiler Chicken

The feed consumption of the birds is presented (Table 1). Broilers supplemented with 20 mL fermented oyster mushroom by-product/L consumed the highest amount of feed (1.43 kg), followed by the 40 mL group (1.31 kg), while the control (1.16 kg) and 30 mL groups (1.06 kg) showed lower intake. Notably, the 30 mL group exhibited a 9% reduction in feed consumption compared to the control. This non-linear response suggests that moderate fermented oyster mushroom by-product levels may enhance satiety or nutrient absorption efficiency, reducing the need for excessive feed intake. The increase at 20 mL aligns with studies reporting improved palatability and fiber digestibility from fermented substrates due to microbial degradation of anti-nutritional factors (Cruz et al., 2011). However, the decline at 30 mL implies a bioactive threshold where oyster mushroom-derived polysaccharides like β-glucan may transiently suppress appetite by modulating ghrelin secretion (Oso et al., 2019). This biphasic pattern mirrors findings for other functional feeds, where low doses stimulate intake via volatile organic compounds (Nguyen et al., 2022), while higher concentrations of phenolic acids induce mild anorexia via hypothalamic signaling (Windisch et al., 2008).

Table 1. Feed Consumption (kg) of Broiler Chicken Supplemented with Fermented Oyster Mushroom By-product

Treatment	Replicate I	Replicate II	Replicate III	Total	Mean ± SD
Control	1.17	1.14	1.18	3.49	1.16 ± 0.03^{c}
20 mL FOMBP/L	1.41	1.47	1.42	4.30	1.43 ± 0.03^{a}
30 mL FOMBP/L	1.10	1.00	1.09	3.19	1.06 ± 0.05^{c}
40 mL FOMBP/L	1.34	1.19	1.39	3.92	1.31 ± 0.10^{b}

Gain in Weight (kg) of Broiler Chicken

The weight gain of the birds is presented in Table 2. The result revealed that the weight gain was highest in the 40 mL fermented oyster mushroom by-product group (1.00 kg), surpassing the control (0.87 kg) by 15% (p <

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0.01; Table 2). A dose-dependent trend was evident at 30 mL (0.94 kg) and 20 mL (0.90 kg) groups that showed intermediate gains. The supplementation of 40 mL correlates with enhanced nutrient bioavailability from fermentation, which liberates peptides, vitamins and short-chain fatty acids (Zhang et al., 2023). Similar gains were reported in livestock fed fermented fungal substrates, attributed to improved protein solubilization (Kim et al., 2012). Immunomodulatory β-glucans in oyster mushrooms likely optimized nutrient partitioning toward muscle deposition by enhancing gut barrier function and reducing inflammation-related energy losses (Katya et al., 2004; Lee et al., 2024). However, the trend beyond 40 mL suggests a nutraceutical ceiling, potentially due to metabolic stress from high bioactive compound, warranting dose-response optimization in future studies loads (Al-Khalaifah et al., 2020).

Table 2. Feed Consumption (kg) of Broiler Chicken Supplemented with Fermented Oyster Mushroom By-product (FOMBP)

Treatment	Replicate I	Replicate II	Replicate III	Total	Mean ± SD
Control	0.88	0.88	0.86	2.62	0.87 ± 0.01[c]
20 mL FOMBP/L	0.89	0.90	0.92	2.71	0.90 ± 0.01[bc]
30 mL FOMBP/L	0.94	0.93	0.96	2.83	0.94 ± 0.02[b]
40 mL FOMBP/L	0.97	1.00	1.04	3.01	1.00 ± 0.03[a]

Feed Conversion Ratio (FCR) of Broiler Chicken

The feed conversion ratio of the birds is presented in Table 3. The result revealed that the 30 mL fermented oyster mushroom by-product group achieved the best FCR (1.13), outperforming the control (1.34) and 20 mL (1.58) groups ($p < 0.01$; Table 3). This highlights superior nutrient utilization efficiency at moderate supplementation. The 30 mL dose's efficacy aligns with studies showing FCR improvements from fungal β-glucans enhancing pancreatic enzyme activity and villus height (Saeed et al., 2023). The poor FCR at 20 mL may reflect energy diversion toward microbiota acclimatization during early probiotic adaptation (Abdel-Moneim et al., 2022). Notably, while 40 mL maximized weight gain, its FCR (1.30) matched the control, indicating unoptimized intake-to-gain ratios. This divergence underscores inverted U-shaped efficacy curves common in fermentation products (Truong et al., 2024), where high doses (e.g., 40 mL) may transiently inhibit digestive enzymes via phenolic acids (Garcia et al., 2024). Economically, the 30 mL dose offers greater relevance for smallholders, potentially reducing feed costs by 9–12% amid grain price volatility (FAO, 2023).

Table 3. Feed Conversion Ratio (FCR) of Broiler Chicken Supplemented with Fermented Oyster Mushroom By-product (FOMBP)

Treatment	Replicate I	Replicate II	Replicate III	Total	Mean ± SD
Control	1.33	1.30	1.37	4.00	1.34 ± 0.04[b]
20 mL FOMBP/L	1.58	1.63	1.54	4.75	1.58 ± 0.05[a]
30 mL FOMBP/L	1.17	1.08	1.14	3.39	1.13 ± 0.05[c]
40 mL FOMBP/L	1.38	1.19	1.34	3.91	1.30 ± 0.10[b]

CONCLUSIONS

This study conclusively determines that the anaerobic fermentation of oyster mushroom (*Pleurotus ostreatus*) by-products yields a liquid supplement capable of enhancing broiler productivity while valorizing agricultural waste. Additionally, supplementation at 30 mL/L significantly improved feed efficiency, reducing the FCR by 16% (1.13 vs. 1.34 in controls; *p* < 0.01) due to enhanced nutrient bioavailability and gut function mediated by fungal β-glucans and fermentation-derived metabolites. While the 40 mL/L supplementation increased weight gain (1.00 kg vs. 0.87 kg in controls), while its FCR mirrored the control (1.30), indicating a trade-off between growth promotion and nutrient optimization. The poorest FCR at 20 mL/L (1.58) likely reflects energy diversion toward microbiota acclimatization. These inverted U-shaped efficacy curves underscore the importance of the levels of supplementation. The 30 mL/L offers small-scale farmers a sustainable, cost-effective strategy to reduce conventional feed dependency by 9–12% without compromising growth performance. Future studies should explore long-term effects, bioactive compound profiling, and economic viability across diverse farming systems.

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