Research Article

Effects of Fermented Restaurant Food Waste on Performance and Carcass Quality of Broiler Chickens

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Abstract | Food waste from restaurants contains nutrients and has potential as an alternative feed ingredient for poultry. This study aimed to assess the impact of incorporating fermented restaurant food waste into poultry feed on broiler chicken performance and carcass characteristics. The study used 80-day-old broiler chickens sourced from PT. Japfa Comfeed Indonesia, which were employed in this trial. The study method employed was an experimental design with a completely randomized design with five dietary treatments and four replications per treatment. The treatments included the use of fermented restaurant food waste (FRFW) with *Bacillus amyloliquefaciens* in the feed: A (0% FRFW), B (10% FRFW), C (20% FRFW), D (30% FRFW), and E (40% FRFW). The variables measured in this study encompassed broiler performance indicators, such as feed intake, weight gain, and feed conversion ratio, in addition to carcass traits, including live body weight, carcass yield, and abdominal fat percentage. The findings indicated that the inclusion of FRFW in the diet did not produce any significant differences ($p > 0.05$) in broiler performance or carcass characteristics, including feed intake, weight gain, feed efficiency, live weight, carcass proportion, and abdominal fat content. The results of the study showed that the inclusion of FRFW at all tested levels did not significantly ($p > 0.05$) affect broiler performance parameters (feed consumption, body weight gain, and feed conversion ratio) or carcass traits (live weight, carcass percentage, and abdominal fat percentage) when compared to the control group (0% FRFW). Based on this study, it can be concluded that the use of fermented restaurant food waste products in broiler feed can be applied up to 40%, where it can maintain both the performance and carcass quality of broiler chickens.

Keywords | Bacillus amyloliquefaciens, Broiler chicken, Carcass quality, Fermentation, Food waste, Performance

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INTRODUCTION

The broiler chicken farming industry continues to grow rapidly to meet the increasing demand for animal protein (Maulana *et al*., 2024). The development of broiler chickens in Indonesia faces a major challenge, which is the high cost of feed, accounting for about 60-70% of the total production cost (Febrina *et al*., 2022). One solution to this issue is the use of alternative, more economical feeds that possess adequate nutritional quality and offer environmental sustainability, which is crucial in improving the efficiency of broiler chicken production (Hidayat *et al*., 2024).

One potential source of alternative feed is food waste from restaurants, which can possess valuable nutritional composition when appropriate feed processing technology is applied (Wizna *et al*., 2023). Food waste from restaurants typically contains various types of organic materials, such as rice, vegetables, meat, and oils, which can serve as sources of energy and protein (Febrina *et al*., 2024).

Based the available literature, the nutritional contents of restaurant food waste after fermentation is presented in Table 1. However, the use of restaurant food waste also presents certain limitations and risks. One of the main challenges is the inconsistency in the composition of waste, which can vary daily depending on food preparation practices and consumer habits. This variability can lead to nutritional imbalances or incomplete fermentation, potentially reducing feed quality or causing health issues in chickens (Salemdeeb *et al*., 2017).

In addition, scaling up the fermentation process for commercial production presents technical and logistical difficulties, such as maintaining optimal microbial activity, controlling temperature and humidity, and preventing contamination (Soccol *et al*., 2017). To mitigate these risks, fermentation technology is applied in broiler chicken feed processing. Fermentation is a biotechnological process involving the activity of microorganisms to improve digestibility, enhance nutrient content, and reduce the levels of anti-nutritional factors or harmful microbes in feed ingredients (Adrizal *et al*., 2021).

Fermentation can increase crude protein content, improve the quality of crude fiber, and enhance nitrogen retention and the digestibility of crude fiber (Ciptaan *et al*., 2022). Additionally, the fermentation process can also produce bioactive compounds that play a role in improving intestinal health in chickens, thereby positively impacting growth and feed efficiency (Sarker and Khatun, 2020).

The performance of broiler chickens is greatly influenced by the quality and balance of nutrients in the feed. Factors such as feed consumption, body weight gain, and feed conversion ratio are key parameters in assessing the effectiveness of alternative feed ingredients. Other factors, such as carcass quality, are also important in determining the economic value of broiler chickens (Listyasari *et al*., 2022). Carcass quality can be evaluated based on carcass weight, carcass percentage, and abdominal fat percentage, all of which are significantly influenced by the nutritional composition of the feed (Anwar *et al*., 2019).

Several previous studies have shown that the use of fermented alternative feed ingredients can improve broiler performance (Anwar *et al*., 2019). However, research on the utilization of fermented food waste from restaurants as broiler feed is still limited. Therefore, further studies are needed to examine how the addition of fermented restaurant food waste (FRFW) in feed affects the performance and carcass quality of broiler chickens. This study aimed to evaluate the effect of adding fermented restaurant food waste to the feed on the performance and carcass quality of broiler chickens.

MATERIALS AND METHODS

Broiler chickens and housing conditions

This study used 80-day-old broiler chickens of the Lohman MB-202 strain, obtained from PT. Japfa Comfeed Indonesia, Hatchery Unit Padang (0°47'10.4"S 100°19'20.1"E). A total of 80 broiler chickens were reared for six weeks in an open-sided poultry house equipped with wire-floored pens. Twenty pens were used, each measuring 70 × 75 × 50 cm, and furnished with feeders, drinkers, heating lamps, and lighting. During the first week, the temperature was maintained between 28-33°C, then gradually reduced to 24-28°C in the subsequent weeks. Relative humidity was kept at 60–70%. Both natural and artificial ventilation were used to ensure proper air circulation, with curtains adjusted according to weather conditions. A lighting program of 23 hours of light and one hour dark per day was applied throughout the rearing period. Data collection began in the second week and continued until the end of the experiment.

Experimental design and feed

This experiment used a completely randomized design (CRD) with feed treatments containing five different percentages of FRFW, namely 0%, 10%, 20%, 30%, and 40%, with each treatment repeated four times. The feed with 0% FRFW was used as the control feed (Treatment A), while the feeds with 10%, 20%, 30%, and 40% FRFW (Treatments B, C, D, E) were the treatment feeds. Each replicate consisted of 4 chickens, total of 16 chickens per treatment group. The experimental design showing CRD with FRFW levels can be seen in Figure 1.

The feed with 0% FRFW was used as the control feed (Treatment A), while the feeds with 10%, 20%, 30%, and 40% FRFW (Treatments B, C, D, and E) were the treatment feeds.

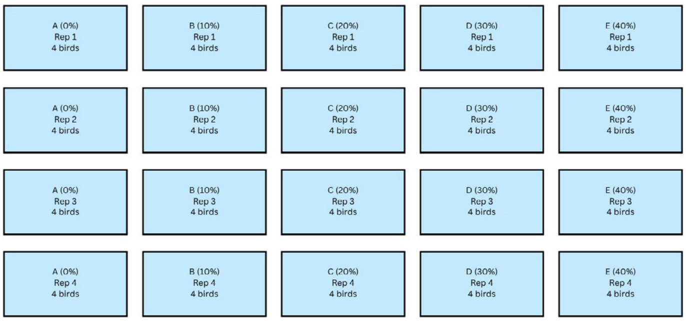

Figure 1: Experimental design illustrating a Completely Randomized Design (CRD) with different FRFW levels.

The potential of restaurant food waste after fermentation, based on its nutritional content, can be seen in Table 1. The feed was formulated independently using ingredients such as yellow corn, soybean meal, fishmeal, FRFW, rice bran, top mix (Refers to a commercial premix containing a blend of essential vitamins, minerals, amino acids and growth-promoting additives; produced by PT. Medion Ardhika Bhakti Indonesia is a commercial premix specifically formulated for poultry) and palm oil, as shown in Table 2. This mixed feed was formulated to have iso-protein (22%) and iso-energy (3000 kcal/kg) content. The feed ingredient composition and the nutritional content of the experimental feed are shown in Table 3.

Table 1: The nutritional potential of restaurant food waste after fermentation.

Nutrient	Content	Reference
Metabolizable energy (kcal/kg)	3.484	Febrina *et al*., 2024
Crude protein (%)	21.41	Febrina *et al*., 2024
Crude fat (%)	7.69	Febrina *et al*., 2024
Crude fiber (%)	5.90	Febrina *et al*., 2024
Calcium (%)	0.84	Wizna *et al*., 2023
Phosphorus (%)	1.25	Wizna *et al*., 2023
Ash (%)	8.57	Wizna *et al*., 2023

Table 2: Nutritional content of experimental feed ingredients.

Feed ingredients *	Crude protein (%)	Crude fat (%)	Crude fiber (%)	Ca (%)	P (%)	Metabolizable energy (kcal/kg)
Corn	9.58	2.66	2.50	038	0.19	3300
Soybean meal	43.78	2.34	2.80	0.63	0.32	2240
Fish meal	47.80	3.22	0.07	3.10	1.89	2540
FRFW	19.25	5.27	5.79	4.66	0.78	3540
Rice bran	12.34	5.09	14.50	0.69	0.26	1630
Top mix	0.00	0.00	0.00	0.06	0.00	0.00
Palm oil	0.00	100.00	0.00	0.00	0.00	8600

*Analyzed by Laboratory of Analysis of Nutrition and Animal Feed, Faculty of Animal Science, University of Andalas (2025); FRFW: Fermented restaurant food waste.

Table 3: Composition of feed ingredients and nutritional contents of experimental diets3

Feed ingredients	Composition of treatment feed (%)				
	A	B	C	D	E
Corn	54.50	48.50	42.50	36.50	26.50
Soybean meal	18.00	15.00	11.75	8.75	5.50
Fish meal	17.00	17.00	17.00	17.00	17.00
FRFW	0.00	10.00	20.00	30.00	40.00
Rice bran	7.00	7.00	7.25	7.25	10.50
Top mix	0.50	0.50	0.50	0.50	0.50
Palm oil	3.00	2.00	1.00	0.00	0.00
Nutritional content of treatment diets*					
Crude protein (%)	22.09	22.13	22.09	22.12	22.07
Crude fat (%)	5.77	5.06	4.36	3.64	3.98
Crude fiber (%)	2.89	3.24	3.61	3.96	4.67
Ca (%)	0.90	1.32	1.75	2.18	2.61
P (%)	0.50	0.56	0.61	0.67	0.73
Metabolizable energy (kcal/kg)	3006	3008	3010	3012	3017

*Calculated based on the nutritional content of the composition and feed ingredients used in the experimental diet. FRFW: Fermented restaurant food waste.

Preparation of fermented restaurant food waste

Restaurant food waste was fermented using the method of Wizna *et al.* (2023). The food waste was collected from several restaurants in Padang City, West Sumatra. Each sampling yielded approximately 20-30 kg of food waste, with a total of 10 sampling events conducted. During collection, non-organic materials such as plastics and packaging were removed, leaving only the edible fraction. The collected waste was then finely ground to achieve homogenization and immediately prepared for the fermentation process.

The homogenized substrate was sterilized using an autoclave for 15 minutes at 121°C under 1 atm pressure to eliminate pathogenic microbes and contaminants. After sterilization, the substrate was cooled to room temperature before microbial inoculation. *Bacillus amyloliquefaciens* was then added at a concentration of 5% and thoroughly mixed to ensure uniform distribution of the microorganism. *Bacillus amyloliquefaciens* used in this study was previously isolated from *Bacillus amyloliquefaciens* cultivated on rice bran (Wizna *et al*., 2023) and maintained at the Feed Industry Technology Laboratory, Faculty of Animal Science, Andalas University, Padang, West Sumatra, Indonesia.

The fermentation process was carried out for five days at an optimal temperature of 40°C to support the growth and metabolic activity of *B. amyloliquefaciens*. After the fermentation period, the fermented material was dried in an oven at 60°C to reduce moisture content and preserve the final product. The resulting product was referred to as fermented restaurant food waste (FRFW).

After fermentation, the feed material was dried and ground for further use. The nutritional composition of FRFW, including crude protein, crude fat, crude fiber, ash, and moisture content, was analyzed using proximate analysis according to AOAC (2005) standards. Calcium (Ca) and phosphorus (P) contents were determined using atomic absorption spectrophotometry and colorimetric methods, respectively.

Broiler performance parameters

Feed intake

The feed intake parameter (g/bird/week) was calculated using the following formula.

Feed Intake (g/bird/week) = Total feed offered (g) – Feed residue (g)

This calculation was performed weekly for each broiler chicken to determine the amount of feed consumed during the rearing period.

Body weight gain

Body weight gain (g/bird/week) was determined by calculating the difference between the final body weight and the initial body weight of each broiler chicken, then dividing this value by the total number of rearing weeks.

Body Weight Gain (g/ bird/ week) = (Final body weight – Initial body weight) / Rearing duration (week)

Feed conversion ratio

The feed conversion ratio (FCR) was computed by dividing the total feed intake by the total body weight gain of the broiler chickens during the experimental period.

FCR = Total feed intake (g) / total body weight gain (g)

Carcass quality parameters

Live weight

Broiler carcass quality includes the measurement of live weight (g), which is determined by weighing at the end of the study.

Carcass percentage

Carcass percentage was calculated by comparing the broiler carcass weight (g) to the live weight (g) in percentage form.

The formula for carcass percentage is as follows:
Carcass percentage of the broiler chicken was determined by dividing the carcass weight (g) by the live body weight (g) and expressing the result as a percentage.

Carcass percentage (%) = (carcass weight / cutting weight) × 100

Abdominal fat percentage

The abdominal fat percentage was obtained by dividing the weight of fat collected from the abdominal cavity and around the digestive organs (g) by the live body weight (g), then multiplying by 100 to express it as a percentage.

Abdominal fat (%) = (Abdominal fat weight / Live body weight) × 100

Statistical analysis

The research data were analyzed using analysis of variance for a Completely Randomized Design. The significance of differences between treatments was tested with Duncan's Multiple Range Test (DMRT), with a significant value at $p < 0.05$ (Steel and Torrie, 1995). Statistical analyses were performed using SPSS software version 25.0 (IBM Corp., Armonk, NY, USA).

RESULTS AND DISCUSSION

Nutritional composition of FRFW

The proximate analysis of FRFW is presented in Table 4. The product contained 19.25% crude protein, 5.27% crude fat, 5.79% crude fiber, 4.66% calcium, and 0.78% phosphorus, with a calculated metabolizable energy of 3540 kcal/kg. These nutrient values indicate that FRFW provides a balanced source of protein and energy for poultry diets. The relatively high protein content suggests its potential as a substitute for conventional feed ingredients. Moreover, the fermentation process using *Bacillus amyloliquefaciens* may contribute to improved nutrient digestibility and reduced anti-nutritional compounds, thereby supporting its use in broiler diets.

Table 4: Nutritional composition of FRFW.

Item*	Value
Crude protein (%)	19.25
Crude fat (%)	5.27
Crude fiber (%)	5.79
Ca (%)	4.66
P (%)	0.78
Metabolizable energy (kcal/kg)	3540

*Analyzed by Laboratory Analysis of Nutrition and Animal Feed, Faculty of Animal Science, University of Andalas (2025).

Broiler performance

The findings indicated that incorporating various inclusion levels of FRFW ranging from 0% to 40% into broiler diets did not lead to statistically significant differences in feed intake, body weight gain, or feed conversion ratio (Table 5, p > 0.05).

Table 5: Average performance of Lohmann MB-202 broiler chickens fed diets containing FRFW during the study.

Treatment (FRFW%)	Feed consumption (g/bird/week)	Body weight gain (g/bird/ week)	Feed conversion ratio
0	542.93 ± 5.08	310.99 ± 10.83	1.75 ± 0.07
10	546.33 ± 8.18	306.20 ± 10.12	1.79 ± 0.07
20	554.68 ± 10.12	296.21 ± 12.83	1.87 ± 0.08
30	549.29 ± 12.37	301.00 ± 20.24	1.83 ± 0.13
40	546.39 ± 6.34	308.35 ± 14.15	1.77 ± 0.10
SE	4.41	7.08	0.05
P-value (p > 0.05)	NS	NS	NS

Description: SE: Standard error, FRFW: Fermented restaurant food waste, NS: Non-significant

The inclusion of FRFW at levels of 10%, 20%, 30%, and 40% in broiler diets did not significantly affect feed intake compared to the control group (0% FRFW, p > 0.05). These findings suggest that the inclusion of FRFW up to a level of 40% in the diet did not negatively influence the palatability or acceptability of the feed, as evidenced by the similar feed intake observed across all treatment groups, including Treatment E (40% FRFW). The consistent feed intake across treatments suggests that the palatability of the feed was similar between the control diet (without FRFW) and the diet containing 40% FRFW (Treatment E). According to Maulana *et al.* (2021), feed intake is influenced by taste, which affects poultry preference for feed. The palatability of FRFW is attributed to the fermentation process using *Bacillus amyloliquefaciens*, which is known to enhance flavor and reduce anti-nutritional factors in food waste (Rusfidra *et al.*, 2025). Ramadhan *et al.* (2021) stated that the application of fermentation biotechnology using *Bacillus amyloliquefaciens* in feed waste can enhance palatability for broiler chickens.

The use of fermented restaurant food waste as an innovative and alternative feed can be incorporated into broiler diets up to 40%, reducing the use of yellow corn by 28% and soybean meal by 12.5%. The study by Hutabarat *et al.* (2021) found that local feed ingredients have the potential as alternative feed sources that can reduce the reliance on corn and soybean meal. Broiler feed intake is highly influenced by the nutritional requirements needed to support growth (Aktar *et al.*, 2024). The findings of this study indicated that fermented restaurant food waste contains nutrients that meet the needs of broiler chickens, leading to similar feed intake across all treatments. Additionally, environmental factors such as temperature, stocking density, and drinking water quality play a crucial role in determining the chickens' appetite.

Body weight gain in treatments B (10% FRFW), C (20% FRFW), D (30% FRFW), and E (40% FRFW) did not show a significant effect (Table 4, p > 0.05). This is because feed intake remained consistent even with the inclusion of up to 40% FRFW. Li *et al.* (2022) stated that feed intake affects the availability of nutrients required for poultry growth. This study indicated that the nutritional quality and digestibility of FRFW, particularly in terms of its crude protein, energy, and fiber digestibility, are comparable to commonly used feed ingredients such as yellow corn and soybean meal. Therefore, FRFW has potential as a sustainable alternative feed component for broiler chickens.

The fermentation process can enhance feed digestibility and reduce antinutritional factors that may inhibit nutrient absorption in chickens (Maulana *et al.*, 2021; Febrina *et al.*, 2024). Fermentation with *Bacillus amyloliquefaciens* may play a role in increasing energy and protein availability (Zurmiati *et al.*, 2024), which are essential for broiler chicken growth (Palupi *et al.*, 2023).

There were no statistically significant differences observed in the feed conversion ratio (FCR) of broiler chickens when fed diets containing varying inclusion levels (0%, 10%, 20%, 30%, and 40%) of FRFW fermented with *Bacillus amyloliquefaciens* (p > 0.05). The result regarding FCR indicated that the inclusion of FRFW at varying levels in broiler diets (10% to 40%) maintained efficiency comparable to the control diet (0% FRFW), as reflected in the consistent FCR values across treatments. The FCR represents the quantity of feed consumed by chickens to achieve a unit increase in body weight (Ezeobele and Onyinye, 2021). The absence of significant differences suggests that the variation in FRFW percentage does not affect how efficiently chickens convert feed into growth. One possible reason for this is that the nutritional quality remains adequate despite changes in feed composition with the inclusion of FRFW. These findings indicated that fermented restaurant food waste can be used as an economical alternative feed without negatively impacting feed efficiency.

The composition of restaurant food waste is highly influenced by seasonal variations, such as changes in the types of ingredients available and consumer eating patterns during specific periods, for example, during Ramadan or national holidays. These fluctuations can affect the nutritional content of the fermented food waste, including levels of protein, fat, and crude fiber. Such variability may lead to inconsistencies in the quality of the resulting feed and could potentially impact animal performance if not properly managed. Therefore, it is essential to regularly evaluate the nutritional quality of the food waste and adjust the feed formulation accordingly to ensure consistent and optimal outcomes throughout the year.

Although fermentation plays a significant role in reducing harmful microbes and improving the safety of feed ingredients, the potential risk of pathogen contamination in food waste-based feed should still be considered. Food waste may initially contain pathogenic bacteria such as *Salmonella* spp., *Escherichia coli*, or *Clostridium* spp., which can pose health risks to poultry. While the fermentation process lowers microbial loads through the production of organic acids and competitive exclusion by beneficial microbes, incomplete or inconsistent fermentation could result in residual pathogenic microorganisms. Therefore, ensuring optimal fermentation conditions and conducting microbial safety tests are essential steps to minimize such risks in practical applications (Adrizal *et al.*, 2021).

Although the inclusion of FRFW in the feed did not result in statistically significant differences in the performance and carcass quality of broiler chickens, its use still offers important economic and sustainability benefits. Utilizing FRFW can reduce feed costs by replacing part of conventional feed ingredients with low-cost food waste that still contains adequate nutritional value. In addition, the use of restaurant food waste helps reduce environmental pollution and supports circular agriculture practices by converting organic waste into valuable livestock feed. These benefits align with the goals of sustainable livestock production and demonstrate the practical relevance of FRFW usage, even in the absence of significant differences in performance parameters.

Broiler carcass quality

In the variable of broiler carcass quality, as shown in Table 6, there was no significant difference between the control group (0% FRFW) and the treatment groups receiving 10%, 20%, 30%, and 40% FRFW in the feed ($p > 0.05$).

The effect of FRFW with *Bacillus amyloliquefaciens* at varying percentages (0%, 10%, 20%, 30%, and 40%) in broiler chicken feed on live weight did not show any significant differences ($p > 0.05$). This indicates that, although the feed contained fermented food waste, the chickens grew well without any significant differences in live weight ($p > 0.05$). The fermentation process with *Bacillus amyloliquefaciens* improves feed digestibility, reduces antinutritional factors, and enhances the availability of nutrients in the food waste (Zurmiati *et al.*, 2024). As long as the alternative fermented feed meets the nutritional needs of the broilers, their growth, measured by live weight, will be similar to that of broilers fed with commercial feed. Live weight in broilers is influenced by feed digestibility and the quality of nutrients (Hossain *et al.*, 2012). Broilers can adjust their eating patterns and feed consumption according to their metabolic needs, which allows them to grow well even when the feed contains different ingredients (Abd El-Hack *et al.*, 2017).

Table 6: The average carcass quality of Lohmann MB-202 broiler chickens fed with FRFW during the study.

Treatment (FRFW%)	Live weight (g)	Carcass percentage (%)	Abdominal fat percentage (%)
0	1668.75±50.72	71.56 ± 1.60	1.98 ± 0.35
10	1649.38±53.19	71.77 ± 6.20	1.99 ± 0.21
20	1598.50±65.97	70.13 ± 1.83	1.58 ± 1.15
30	1625.69±108.00	68.11 ± 5.28	1.88 ± 0.72
40	1657.19±68.96	65.09 ± 1.62	1.25 ± 0.24
SE	18.09	0.97	0.16
P-value (p > 0.05)	NS	NS	NS

SE: Standard error, FRFW: Fermented restaurant food waste, NS: Non-significant.

The carcass percentage of broiler chickens did not show any significant effect with varying amounts of restaurant food waste in their feed. Fermentation with *Bacillus amyloliquefaciens* enhances feed digestibility and reduces antinutritional factors (Wizna *et al.*, 2023). After fermentation, the nutrient content of the restaurant food waste meets the nutritional needs of the broilers, so the growth of the carcass remains optimal without any significant differences, despite variations in the percentage of fermented food waste. The carcass of broiler chickens is influenced by many factors, including genetics, feed composition, and management practices (Zuidhof *et al.*, 2014; Biyatmoko *et al.*, 2021). The results of this study, showed that fermented restaurant food waste with *Bacillus amyloliquefaciens* did not affect the carcass percentage of broiler chickens ($p > 0.05$), suggest that fermented food waste can be used as an alternative feed without impacting the quality of the carcass, as long as the feed meets the basic nutritional requirements of the broiler chickens.

The abdominal fat percentage of broiler chickens did not differ significantly ($p > 0.05$) among the treatment groups receiving 10%, 20%, 30%, and 40% fermented restaurant food waste compared to the control group (0% FRFW). This finding indicated that despite variations in the amount of food waste in the feed, the abdominal fat of the broilers remained unchanged. The consistent values of feed intake, weight gain, and feed conversion ratio (Table 5) suggested that the nutrition provided and the digestibility of the feed were similar, even though yellow corn and soybean meal were reduced and replaced with FRFW in the broiler feed. One factor influencing abdominal fat accumulation is the overall composition of the feed (Zhang *et al*., 2017). Feeding diets with excessive fat and energy can increase abdominal fat accumulation (Zhou *et al*., 2009). When fermented feed products are included in broiler feed in a balanced way, either in terms of energy or fat, abdominal fat accumulation will not increase, even with variations in fermented food waste levels. Zhang *et al*. (2017) found that broiler chickens have mechanisms to regulate fat deposition in their bodies, influenced by genetics, age, and management practices.

CONCLUSIONS AND RECOMMENDATIONS

The use of fermented restaurant food waste in broiler chicken feed up to 40%, maintaining both the performance and carcass quality of the broiler chickens. Future studies are recommended to investigate the long-term health and immune responses of broilers fed with FRFW, analyze its microbiological safety, assess its economic feasibility on a commercial scale, and evaluate the seasonal variability in food waste composition and nutritional consistency.

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NOVELTY STATEMENT

This study provides one of the earliest evaluations of restaurant food waste fermented with *Bacillus amyloliquefaciens* (FRFW) as a poultry feed ingredient at inclusion levels up to 40%. The research employs a rarely used fermentation technique adapted from Wizna *et al*. (2023), incorporating an initial sterilization step and controlled optimal fermentation temperature to enhance product quality. The findings demonstrate that high-level inclusion of FRFW does not compromise broiler performance or carcass traits, underscoring its feasibility as a sustainable feed substitute. Overall, this work advances circular economy practices in poultry production by converting restaurant organic waste into a nutritionally beneficial feed resource.

AUTHOR'S CONTRIBUTION

W: Responsible for the research design and methodology used. RA: Played a role in data collection and statistical analysis to ensure the accuracy of the results. RA: Focused on laboratory experiments and testing of materials used in the study. R: contributed to the writing and editing of the manuscript to meet scientific publication standards. Meanwhile, FM: Ensured the validity of the results by conducting a comprehensive literature review. SYA: Acted as the lead coordinator, directing the research process and coordinating collaboration among the authors to successfully complete this study.

Ethical approval

This research was conducted after receiving ethical approval under the Minister of Agriculture Decree No. 306/KPTS/TN.330/4/1994, which was approved by the Animal Research Ethics Committee of Andalas University, Padang, Indonesia, required for the use of experimental animals in research and teaching.

Generative AI and AI-assisted technology statement

The authors declare that ChatGPT (OpenAI, San Francisco, CA, USA) was used to assist in the initial translation of the manuscript from Indonesian to English. All outputs were reviewed, edited, and verified by the authors to ensure accuracy and originality.

Conflict of interests

The authors have declared no conflict of interest.

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