



Which is better, non-fermented or fermented diets?: The case of production of broilers

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ABSTRACT

The broilers food was provided from fermented and non-fermented of the raw materials. Fermentation utilizes microorganisms to transform raw materials into useful products, resulting in the production of nutritionally enriched, very stable food products from low-value carbohydrate and protein substrates. Therefore, this study aimed to assess the growth performance, return above feed cost and mortality of broilers given a non-fermented (control) and fermented feeds using plain water, water+15 ml coco vinegar and water +15 ml RPL8+AKE probiotic as fermenting agents. The fermentation process lasted for 72 hours inside tightly covered container in a dark room at room temperature. A total of 120 broiler chicks were randomly assigned to four treatment diets and were replicated three times with ten birds per replication following a Complete Randomized Design set-up. Data on cumulative weekly weight gain (CWWG), average daily gain (ADG), and feed conversion ratio (FCR) were subjected to one-way Analysis of Variance (ANOVA) and comparison between treatment means was done by Honestly Significant Difference test using the SPSS version 20.0. Results revealed a better growth performance of broilers under non-fermented diet compared with fermented diets. Significantly ($p < 0.01$) highest ADG on broilers fed with non-fermented ration ($m=0.397g$, $sd=0.0086g$), followed by water+15 ml coco vinegar ($0.365g$), water+15 ml RPL8+AKE probiotic ($m=0.343g$, $sd=0.0114g$) and plain water ($m=0.314g$, $sd=0.0057g$). Although below the Philippine average (2.0) and standard (1.9) FCR, broilers fed with non-fermented diet had the better FCR (2.3) than those fed with fermented rations. The lowest feed cost and positive return above feed cost on broilers given fermented diets imply a negative impact on the expected profit in poultry production instead of non-fermented ration. However, no mortality was recorded for broilers given a fermented diets which implies that it produces vigorous broilers.

Introduction

The economic importance of many poultry species and the poultry industry particularly as sources of meat and eggs, cannot be overemphasized. Specifically, the Philippine broiler industry which is characterized by widely diverse production and marketing systems (Curibot *et al.*, 2019; Tanquilut *et al.*, 2020). Perhaps, Philippine broiler industry consists of a few but very large integrated livestock enterprises on one end, and a very large number of small hold farmers keeping few heads of poultry on the other end (BPC, 2006). Meanwhile, in the middle are the medium-scale producers who depend largely on the integrated livestock enterprises for supply of breeding stocks and feedstuffs. It is worth noting that the poultry industry of the Philippine agricultural

sector is one of the major sources of income. About 30% of the country's total gross value added (GVA) came from livestock and poultry industry (PSA, 2017). Furthermore, poultry industry serves as one of the major sources of protein for Filipino diet (PSA, 2018).

According Sugiharto and Ranjitkar (2019), it is stated that broiler feed contributes up to 70% of the production cost in the production of commercial poultry. Seemingly, due to constant increase over time in feed prices, poultry industry shifted to alternative feed ingredients. One of the alternative food process is the fermentation of livestock feeds. Fermentation utilizes microorganisms to transform raw materials into useful products, resulting in the production of nutritionally enriched, very stable food

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products from low-value carbohydrate and protein substrates. Another purpose of fermentation of feeds is to improve the growth performance and strengthen the immune system of a livestock (Chen & Yu, 2020). Hence, this process preserves food and enhances the sensory qualities of the product and leads to improved nutritional value through enrichment with microbial protein, amino acids, lipids and vitamins, and by reducing the level of anti-nutrients in the feeds (Niba *et al.*, 2009; Olukomaiya *et al.*, 2019). Perhaps, protein sources are important in feed diets in poultry industry (Olukomaiya *et al.*, 2019). Wolfe and colleagues (2018) mention that protein is a dietary macronutrient required for life and reasonably considered as dietary protein diet as the core of a healthy eating pattern. On the other hand, some authors cited that Lactic acid bacteria is known to produce enzymes and natural antibiotics aiding effective digestion and has antibacterial and toxin elimination properties (Barbieri *et al.*, 2019; Landete *et al.*, 2005; Vieco-Saiz *et al.*, 2019; Vinderola *et al.*, 2019). Furthermore, Zhang *et al.* (2005) observed that diets supplemented with fermented feeds improve broiler weight gain, feed intake, and feed efficiency.

Although several reports favored the use of fermented diets and the incorporation of vinegar and probiotic into the drinking water, the use of plain water, coco vinegar, and probiotic (RPL8+AKE) fermenting agents for broiler diets is not well documented. In the study of Patterson and Burkholder (2003), it is stated that probiotics are approaches that have the potential to reduce disease in poultry and subsequent contamination of poultry products. This is supported in Parvez and colleagues (2006) study, which stated that probiotics and fermented foods are beneficial for the immune system and health. Hence, this study was conducted to assess the growth performance, return above feed cost and mortality of broilers given a non-fermented diets as control and fermented diets using plain water, water + 15 ml coco vinegar and water + 15 ml RPL8+AKE probiotic as fermenting agents. The result of this study is useful in improving the feeding pattern of broilers and aid as a benchmark for further studies.

Materials and Methods

Preparation of experimental broilers and cages

A total of one hundred twenty (120) day-old Cobb Strain straight-run broiler chicks were used in this study. The experimental broiler chicks were purchased from a reliable store and selected based on

the criteria in assessing chick quality by Lambio (2010), as shown in Table 1.

Prior to the arrival of the broiler chicks, the brooding and growing pens and housing facilities were properly cleaned and disinfected. The experimental cages were lighted day and night during the brooding stage and provided with protective cover against draft and strong winds. During the growing stage, cages were lighted only at night and the protective cover was rolled up for proper ventilation during daytime when weather is fine. Figure 1 shows the newly purchase chicks of broilers.

Table 1. Criteria in Assessing Chick Quality (Lambio, 2010).

| Criteria | Conditions |
|------------------------|---|
| Age | Newly hatched (day-old) |
| Weight | Not less than 35 g |
| Size | Uniform in size with other chicks in the flock |
| Appearance | Healthy and active Do not appear dehydrated |
| Physical abnormalities | Free from blindness, splay leggedness, cross beaks and pale down feathers |
| Gross lesions | Free from overly enlarged abdomen, wet navels and vent pasting |

Preparation of experimental diets

The plain water, water +15 ml coco vinegar, and water +15 ml RPL8+AKE probiotic as fermenting agents were added and mixed with the commercial feed to prepare the treatment diets. The fermentation process lasted for 72 hours inside a tightly covered container in a dark room at room temperature. The feed was totally submerged with the fermenting liquid and stirred two to three times a day to prevent contamination. To have a continuous supply of the fermented feeds, the experimental diets were prepared at regular intervals based on the requirement for the whole duration of the study. Furthermore, the total feed given per bird per day was based on the recommended daily feed requirement for broilers. The feeding experiment using plain water, water+15 ml coco vinegar and water + 15 ml RPL8+AKE probiotic fermented diets on broilers was conducted at the Poultry Project of Visayas State University Laboratory High School, Visayas State University, Visca, Baybay City, Leyte, Philippines.

Management of experimental broilers

Upon the arrival of the broiler chicks, only fresh drinking water with dextrose powder and multivitamins was given immediately after weighing to recover from stress. A 7-day brooding period using appropriate litter materials and 50-watt electric bulbs as an artificial heat source for the brooding area was done. The behavior of the chicks inside the brooding cage and the cleanliness of the pen was regularly monitored until the end of the brooding period. During the brooding period, a commercial booster ration was given to the chicks twice a day, 6:00 AM and 3:00 PM, and fresh drinking water was provided at all times. Before the intra-ocular NCD vaccination on the 7th day, dextrose powder and multivitamins were added to the drinking water.

After the 7-day brooding period, the chicks were weighed and randomly transferred to the experimental cages to start the feeding trial during the growing period. The standard period of gradual shifting of diet from pure commercial ration to experimental fermented diets was followed. The fermented rations were given twice a day at 6:00 AM and 3:00 PM as wet mash starting on the second week until five weeks (35 days) old. The phase feeding method was followed, and the total feed given per bird per day was based on the recommended daily feed requirement of broilers. Fresh drinking water was provided all throughout the study's duration, and vitamin-mineral premix was added to the drinking water at regular intervals. The recommended biosecurity measures were strictly observed, and a health program with restricted use of antibiotics was also followed, as shown in [Table 2](#).

Table 2. Health program of broilers fed with plain water, coco vinegar, and RPL8+AKE probiotic fermented diets (Lambio, 2010).

| Age (days) | Treatment |
|-------------------------|---|
| 1 st 4 hours | Electrolyte (1/2tsp/gal) |
| 1-7 | Electrolyte (1/2tsp/gal) and Multivitamins (2tsp/gal) |
| 8 | NCD B ₁ B ₁ vaccine (intranasal) Multivitamins (2tsp/gal) |
| 9-15 | Multivitamins (2tsp/gal) |
| 16 | Cocciostat (2g/gal) |
| 17-23 | Plain Water |
| 24-30 | Multivitamins (2tsp/gal) |
| 31-45 | Plain Water |

Treatment diets and experimental design

The following dietary treatments were given based on the daily feed requirement of broilers: T₀ (Non-fermented ration, Control); T₁ (Fermented ration

using plain water); T₂ (Fermented ration using water +15ml Coco Vinegar); T₃ (Fermented ration using water +15ml RPL8+AKE Probiotic).

A total of (120) day-old Cobb Strain straight-run broiler chicks were randomly assigned to four (4) treatment diets and replicated three (3) times with ten (10) birds per replication. The experiment was laid out in a Complete Randomized Design (CRD) set-up as follows:

Table 3. Experimental layout using Complete Randomized Design (CRD).

| | | |
|-------------------------------|-------------------------------|-------------------------------|
| T ₂ R ₁ | T ₁ R ₂ | T ₀ R ₂ |
| T ₃ R ₂ | T ₀ R ₁ | T ₂ R ₃ |
| T ₂ R ₂ | T ₃ R ₃ | T ₁ R ₃ |
| T ₁ R ₁ | T ₀ R ₃ | T ₃ R ₁ |

Data Analysis

For the data analysis, the following formulae were used (Lambio, 2010):

Cumulative Weekly Weight Gain (CWWG) was the weight gain of the broilers at the weekly interval and was computed using the formula: Weight Gain (g) = Final weight (kg) - Initial weight (kg).

Average Daily Gain (ADG) measures the daily gain in weight of broilers and was computed using the formula:

$$ADG (g) = \frac{\text{Final weight} - \text{Initial weight}}{\text{Number of feeding days}}$$

Feed Conversion Ratio (FCR) is the amount of feed needed to grow the broilers and was computed using the formula:

$$FCR = \frac{\text{Total feed intake (g)}}{\text{Total weight gain (g)}}$$

Percent Mortality Rate was computed using the following formula:

$$\text{Mortality (\%)} = \frac{\text{Total number of dead broiler}}{\text{Total number broiler}} \times 100$$

Feed Cost (FC) is the cost of feed consumed and computed using the formula: Feed Cost (₱) = Average Feed Intake (kg) x Price/kg feed

Return Above Feed Cost (RAFC) measures the production return based on the cost of feeds and computed as follows: RAFC = Sale of Broilers – Feed Cost.

Data gathered were subjected to one-way Analysis of Variance (ANOVA), and comparison of treatment means was done using Tukey’s (HSD) Test of SPSS version 20.0.

Results

Cumulative weekly weight gain (CWWG)

The Cumulative weekly weight gain of broilers fed with fermented diets using different fermenting

agents are significantly different ($p < 0.01$) in weeks 2, 3, 4, 5, and 6 (Table 4 and Figure 1). From week 2 to

Table 4. Cumulative weekly weight gain (g) of broilers fed with plain water, coco vinegar and RPL8+AKE probiotic fermented diets.

| Treatment | Weight (g) | | | | | | | | | | | |
|--|----------------------|--------|----------------------|--------|----------------------|--------|----------------------|--------|----------------------|--------|----------------------|--------|
| | Week 1 ^{ns} | | Week 2 ^{**} | | Week 3 ^{**} | | Week 4 ^{**} | | Week 5 ^{**} | | Week 6 ^{**} | |
| | m | sd | m | sd | m | sd | m | Sd | m | sd | m | sd |
| T ₀ (Non-fermented ration, Control) | 150 ^a | 0.0577 | 377 ^a | 0.0577 | 660 ^a | 0.1000 | 910 ^a | 0.1000 | 1250 ^a | 0.1000 | 1547 ^a | 0.3055 |
| T ₁ (Fermented ration, plain water) | 153 ^a | 0.1000 | 317 ^c | 0.1155 | 553 ^c | 0.1528 | 830 ^c | 0.2000 | 1027 ^c | 0.1155 | 1250 ^c | 0.3000 |
| T ₂ (Fermented ration, water + 15ml coco vinegar) | 156 ^a | 0.0577 | 350 ^b | 0.1000 | 593 ^b | 0.0577 | 873 ^b | 0.0577 | 1195 ^b | 0.1323 | 1430 ^b | 0.4000 |
| T ₃ (Fermented ration, water + 15ml probiotic) | 156 ^a | 0.0577 | 337 ^{bc} | 0.0577 | 577 ^{bc} | 0.0577 | 857 ^{bc} | 0.0577 | 1180 ^b | 0.1000 | 1357 ^b | 0.3512 |

** - Column means with no common superscripts are significantly different ($p < 0.01$)

ns - Column means are not significant

week 6, consistently highest Cumulative weekly gain in weights (m=377g, sd=0.0577g; m=660g, sd=0.1000g; m=910g, sd=0.1000g; m=1250, sd=0.1000; and m=1547g, sd=0.3055) were obtained on broilers fed with non-fermented ration, and this was followed by fermented diet using plain water + 15 ml coco vinegar (m=350g, sd=0.1000g; m=593.3g, sd=0.0577g; m=873g, sd=0.0577g; m=1195g, sd=0.1323g; and m1430g, sd=0.4000g). From weeks 2, 3, 4, 5, and 6, CWWG of broilers under fermented diet using plain water reflected consistently lowest (m=153g, sd=0.1000g; m=317g, sd=0.1155g; m=553g, sd=0.1528; m=830g, sd=0.2000; m=1027g, sd=0.1155g, and m=1250g, sd=0.3000 respectively), but these were not significantly different from CWWG (337g, 577g, and 857g) of broilers fed with a fermented diet using water + 15 ml RPL8+AKE probiotic as fermenter during weeks 2, 3 and 4, respectively.

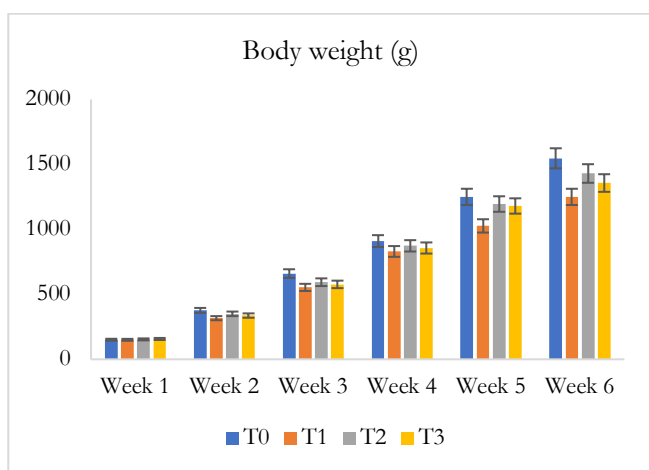


Figure 1. Cumulative weekly gain in weight (g) of broilers fed with plain water, coco vinegar and RPL8+AKE probiotic fermented diets.

Average daily gain (ADG)

The average daily gain in weight (ADG) of broilers fed with plain water, water + 15 ml coco vinegar, and water + 15 ml RPL8+AKE probiotic fermented diets are presented in Table 5 and Figure 2. Results revealed significantly ($p < 0.01$) highest ADG on broilers fed with non-fermented commercial ration (m=0.397g, sd=0.0086) and lowest ADG on broilers under fermented diet using plain water (m=0.314g, sd=0.0057).

Table 5. Average daily gain (g) of broilers fed with plain water, coco vinegar, and RPL8+AKE probiotic fermented diets.

| Treatment | Average Daily Gain (m)** | Standard Deviation (SD) |
|---|--------------------------|-------------------------|
| T ₀ (Non-fermented ration, Control) | 0.397 ^a | 0.0086 |
| T ₁ (Fermented ration, plain water) | 0.314 ^c | 0.0057 |
| T ₂ (Fermented ration, water + 15 ml coco vinegar) | 0.365 ^b | 0.0129 |
| T ₃ (Fermented ration, water + 15 ml RPL8+AKE probiotic) | 0.343 ^b | 0.0114 |

** - Column means with no common superscripts are significantly different ($p < 0.01$).

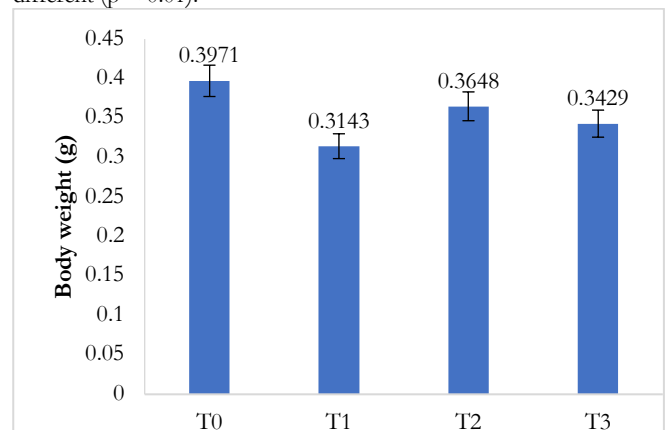


Figure 2. Average daily gain (g) of broilers fed with plain water, coco vinegar and RPL8+AKE probiotic fermented diets.

Feed conversion ratio (FCR)

Results disclosed a highly significant ($p < 0.01$) feed conversion ratio (FCR) of broilers fed with plain water, water + 15 ml coco vinegar, and water + 15 ml RPL8+AKE probiotic fermented diets (Table 6 and Figure 3). Generally, it was observed that data obtained on FCR was far below the Philippine average (2.0) and standard (1.9). It was noted that broilers fed with a non-fermented diet (Control) had the better FCR (2.3) while those fed with fermented ration using plain water reflected the most inferior FCR (2.8).

Table 6. Feed conversion ratio (FCR) of broilers fed with plain water, coco vinegar, and RPL8+AKE probiotic fermented diets.

| Treatment | FCR* |
|--|------------------|
| T ₀ (Non-fermented ration, Control) | 2.3 ^a |
| T ₁ (Fermented ration, plain water) | 2.8 ^c |
| T ₂ (Fermented ration, water + 15 ml coco vinegar) | 2.5 ^b |
| T ₃ (Fermented ration, water + 15 ml RPL8 +AKE probiotic) | 2.6 ^b |

* Column means with no common superscripts are significantly different (p -value < 0.01).

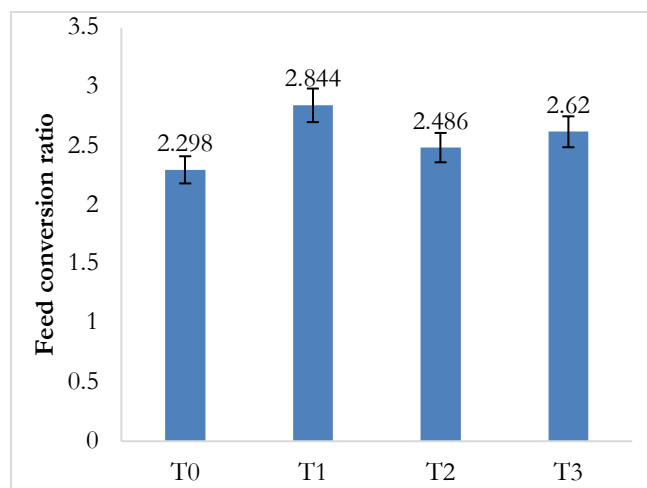


Figure 3. Feed conversion ratio (FCR) of broilers fed with plain water, coco vinegar and RPL8+AKE probiotic fermented diets.

Feed cost (FC)

The feed cost (FC) per head of broilers fed with plain water, water + 5 ml coco vinegar and water + 5 ml RPL8+AKE probiotic fermented diets are exhibited in Table 7 and Figure 4. This was computed based on the cost of commercial feeds, fermenting

agents, and fermentation in the treatments using fermented diets.

Return above feed cost (RAFC)

Table 8 shows the return above feed cost on broilers fed fermented diets using plain water, water + 15 ml coco vinegar, and water + 15 ml RPL8+AKE probiotic as fermenting agents. The broilers fed non-fermented ration reflected a positive RAFC of PhP 32.86 while broilers under the fermented rations obtained negative FRC of -PhP21.74 (water + RPL8+AKE probiotic), -PhP18.30 (plain water) and -PhP3.25 (water + 15 ml coco vinegar).

Table 7. Feed cost (per bird) of broilers fed with plain water, coco vinegar, and RPL8+AKE probiotic fermented diets

| Treatment | Feed Cost (PhP) |
|---|-----------------|
| T ₀ (Non-fermented ration, Control) | 106.64 |
| T ₁ (Fermented ration, plain water) | 130.80 |
| T ₂ (Fermented ration, water + 15 ml coco vinegar) | 131.95 |
| T ₃ (Fermented ration, water + 15 ml RPL8+AKE probiotic) | 144.14 |

Table 8. Return above feed cost (RAFC) on broilers fed with plain water, coco vinegar and RPL8+AKE probiotic fermented diets

| Treatment | Sale from Broilers (PhP) | Feed Cost (PhP) | RAFC (PhP) |
|---|--------------------------|-----------------|------------|
| T ₀ (Non-fermented ration, Control) | 139.5 | 106.64 | 32.86 |
| T ₁ (Fermented ration, plain water) | 112.5 | 130.80 | -18.30 |
| T ₂ (Fermented ration, water + 15 ml coco vinegar) | 128.7 | 131.95 | -3.25 |
| T ₃ (Fermented ration, water + 15 ml RPL8+AKE probiotic) | 122.4 | 144.14 | -21.74 |

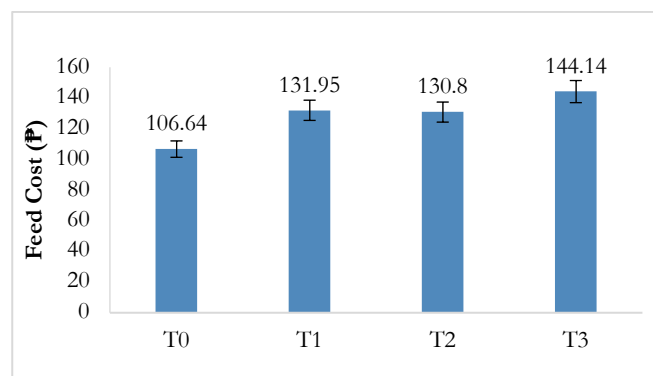


Figure 4. Feed cost (per bird) of broilers fed with plain water, coco vinegar and RPL8+AKE probiotic fermented diets.

Discussion

Result reveals that except for the broilers given non-fermented diets, the average final live weight (ALW) on fermented diets were below the Philippine average (1.5-1.8 kg) and standard (1.55). The overall result revealed better growth performance on a non-fermented diet compared with fermented diets. This was in line with the study of [Ahmad \(2004\)](#) that it did not detect any sign of progress in terms of weight under fermented diets compared to control. Moreover, results coincided with studies of [Zuanon et al. \(1998\)](#), [Patidar and Prajapati \(1999\)](#), [Ergun et al. \(2000\)](#), [Kumprechtova et al. \(2000\)](#), and [Pinchasov and Elmaliah \(1995\)](#) that giving of probiotic and vinegar as a fermenting agent has no effect on the performance of broilers. The ADG of broilers fed with fermented ration using water + 15 ml coco vinegar (0.365g) did not significantly vary with the ADG of broilers fed with fermented ration using water + 15 ml RPL8+AKE probiotic (0.343g). Results conformed with [Ergun et al. \(2000\)](#), who mentioned that supplementation of probiotic as fermenter has no effect on the performance of broilers. Moreover, [Kumprechtova et al. \(2000\)](#) observed that fermented feeds have no effect on chicken's live weight. Although slightly better, the FCR of broilers fed with fermented diets using water + 15 ml coco vinegar (2.5) did not significantly differ with the FCR of broilers fed with water + RLP8+AKE probiotic (2.6) fermented diet. However, the results contradicted with [Leeson et al. \(2005\)](#), who observed an improved feed conversion ratio in fermented dietary treatments compared to the non-fermented ration.

Results disclosed that the additional cost for the liquid probiotic, coco-vinegar, and fermentation task resulted in the highest feed cost incurred in the fermented ration using water + 15 ml RPL8+AKE probiotic (PhP 144.14) compared with fermented ration using water + 15 ml coco vinegar (PhP 131.95) and fermented ration using plain water (130.80). The lowest feed cost (PhP 106.64) was obtained on broilers fed with non-fermented ration compared with any of the fermented diets (T1, T2 and T3), and implies a negative impact on the use fermented diets in terms of the expected profit in poultry production. The small final average live weight (ALW) of broilers given fermented diets ([Table 3](#)) and the additional expense due to the cost of fermenting agents elicited negative return above feed cost on these treatments. It should be noted that the least RAFC was obtained in broilers fed with probiotic fermented ration though it has higher ALW compared with plain water

fermented diet. It suggests that the higher ALW in probiotic fermented diet cannot offset the cost of probiotic as a fermenter.

During the whole duration of the study, no mortality was recorded on broilers fed with fermented diets using plain water, water + 15 ml coco vinegar and, water + 15 ml RPL8-AKE probiotic as fermenting agents. This shows that broilers fed with fermented diets are vigorous and less likely to have enteric diseases that cause lost productivity and increased mortality. Perhaps, it minimizes the association of contamination of poultry products for human consumption and promotes human food safety ([Patterson and Burkholder, 2003](#); [Sugiharto and Ranjitkar, 2019](#)).

Conclusions

In this study, it is concluded that fermented diets show a slow growth performance for broilers relative to non-fermented diets. In other words, broilers are more productive in growth when it is fed with non-fermented diets. Conclusively, it is impractical to give fermented diets based on the negative return above feed cost due to the additional cost of fermenting agents. However, broilers fed with fermented food had shown no mortality rate, which implies that it produces vigorous broilers. This study recommends reassessing the performance of broilers using the same fermenting agents but at higher levels and establish the optimum level of inclusion and assess its blood for animal health's reasons. Moreover, laboratory analysis of the fermenting agents in terms of microbial population and differential count should be conducted to dismiss the possibility of the presence of harmful contaminants.

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