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Feasibility of banana (*Musa acuminata* Linn.) fruit rejects as a dietary supplement to recuperate the production performance of growing Japanese Quails

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Abstract

Quail production is becoming more popular because it may help close the gap between supply and demand in the meat and egg industry. However, one of the major problems in quail farming is the high feed cost, but this can be reduced if agricultural waste by-products are utilized as feedstuff. A feeding trial was conducted to assess the feasibility of rejected banana fruit meal (BFM) on the production performance of growing Japanese quails. A total of 120 female Japanese quails were assigned to four treatments with three replications having ten birds in every replication and carried out in a Completely Randomized Design experimental set-up. The Japanese quails were fed *ad libitum* with commercial ration supplemented with varying levels of BFM, 0% (T_1), 5% (T_2), 10% (T_3), and 15% (T_4), and the production performance was observed within 42 days experimental period. The result showed a significant difference ($p<0.05$) on the final weight, and quails fed with 5% BFM is heavier but statistically comparable to those fed without BFM. Although a significant difference was observed in the final weight, the body weight gains and feed conversion ratio were not statistically affected. Numerically, quails fed with 5% BFM improved the BWG, ADG, and FCR compared to the quails fed with 0%, 10%, and 15% BFM. In conclusion, 5% BFM disclosed a higher profit and can be incorporated in quail diets without adverse effects on the economic traits and growth performance.

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Introduction

The demand for poultry products such as poultry eggs has consistently surged over the years due to an increase in the world population, particularly in developing countries (Ravindan, 2011). This increase directly affects the availability and price of inputs such as feeds. Several types of feeds were utilized in many regions depending on the availability and seasonal conditions. Some of these feeds are not commonly known but are used locally by farmers (Erener *et al.,* 2003). Feed additives should guarantee proper growth and development and guard against diseases (Alagawany *et al.,* 2015). However, major constraints include high costs of commercial feeds, thus shifting to the utilization of local alternative crops that are cheap, locally available, and have potential as a feed component to the production of feeds (Diarra, 2018).

On the other hand, fruits and vegetable waste has been utilized as animal feed to combat feed shortages. These wastes are enriched with proteins, soluble sugars, and minerals (Khattak and Rahman, 2017). Several studies investigated the efficacy of these wastes as a potential feed additive for animals (Angulo *et al.,* 2012; Wadhwa and Bakshi, 2013). One of the fruit wastes generated in massive amounts annually is banana fruit.

This waste is rich in compounds that could be utilized as a low-cost raw material to create value-added products while minimizing pollution (Kamal, 2015). Backyard egg farmers in the Philippines are also not interested in adding more production costs. Thus, maneuvering additional diets like feed additives from fruit wastes has gained more attention.

Cavendish banana (*Musa acuminata* Linn.) is considered an important food next to rice, corn, and milk (Arumugam and Manikandan, 2011). The total world banana production is estimated to be 115.7 million tons (FAO, 2018). In the Philippines, approximately 9.3 million tons of bananas are produced annually and ranked 3rd among the world's top banana-producing countries (FAO, 2018). In Africa and Central America, banana fruits are blended as feed for livestock in tropical regions where resources are scarce (Kramer, 2014). However, the utilization of banana plants as feed is limited by several factors such as high fiber in the stem and leaves and high-water content that can easily damage the banana plant. Banana was utilized as feed for swine (Pengsawad *et al.,* 2018), livestock (Kramer, 2014), poultry (Mandey *et al.,* 2015), and fish (Giri *et al.,* 2016). However, no research has been conducted on utilizing banana fruit wastes as a feed additive to quails. Thus, this study was undertaken to investigate the feasibility of banana fruit wastes as feed supplements to recuperate the production performance of growing Japanese Quails.

Methodology

Experimental birds, cages, and management

The procedures in conducting this feeding trial are in accordance with the Good Animal Husbandry practices guidelines in rearing poultry and livestock animals in the Philippines (PNS/BAFPS, 2008). The study used 120 female Japanese quails raised at the College of Agriculture's Poultry Experimental House in Sultan Kudarat State University - Lutayan Campus.

The brooding pen with a measurement of 4ft (length) × 2.5ft (width) and 1.5ft (height) was constructed before the arrival of the day-old quails and disinfected using a commercial disinfectant. Old newspapers were used as bedding or litter and were replaced daily. Two 50-watt electric bulbs were provided as a source of artificial heat to regulate their body temperature. During the brooding stage, the chicks were given commercial chick booster mash and fed *ad libitum* for 1-14 days. On the 15th day, the experimental quails were transferred to the grower-layer cages following the recommended space requirement of 16 inches per bird (Capitan, 2003), and the experimental ration for Japanese quails was provided. The PVC water pipe measured 91.44cm long, 10.16cm wide, and 5.10cm tall, was utilized as feeders and waterers. Appropriate ventilation and avoidance of freezing temperatures in the experimental house were also considered.

Feeding and water management

The experimental birds were fed *ad libitum* from 15th to 42nd day with their corresponding diets. The feed refuse was collected and weighed every morning, and a separate feeder was provided for all treatments. Fresh, clean drinking water was available during the feeding experiment.

Preparation of banana fruit meal

The rejected cavendish banana fruit was collected from Al-wali Manpower Corporation (AMC) Banana plantation at Barangay, Mamali, Lutayan, Sultan Kudarat. The collected reject cavendish banana fruits were chopped into small pieces and sun-dried for three (3) days. The dried banana fruits were hammer milled and sieved through 1mm to produce banana fruit meal and stored in a large plastic container. The chemical composition of the banana fruit meal was analyzed following the official methods of the Association of Official and Analytical Chemists (AOAC, 2016).

Experimental design and diet

The experiment was replicated three (3) times and laid out in a Completely Randomized Design experimental set-up, with ten (10) birds in each replication. The experimental treatments were as follows:

T_1 – Commercial ration + 0% banana fruit meal

T_2 – Commercial ration + 5% banana fruit meal

T_3 – Commercial ration + 10% banana fruit meal

T_4 – Commercial ration + 15% banana fruit meal

Statistical analysis

One-way analysis of variance (ANOVA) was used to assess the data, and Tukey's Honest Significant Difference was used to compare the means (HSD). The data were analyzed using the Statistical Package of Social Science software, version 17.0, and results with $p<0.05$ were considered significant.

Results and discussion

Growth performance traits

The chemical analysis of banana fruit meal (BFM) indicates that this feedstuff can be a good source of feed in growing Japanese quails (Table 1).

The effects of the varying levels of BFM on the growth performance of Japanese quails are presented in Table 2.

Table 1. Proximate analysis of banana fruit meal (BFM).

Parameters	Chemical analysis
Moisture Content (MC), %	16.17
Dry Matter (DM), %	83.83
Crude Protein (CP), %	14.69
Phosphorus (P), %	0.75
Potassium (K), %	3.78
Calcium (Ca), %	0.42
Magnesium (Mg), %	0.01
Iron (Fe), ppm	0.04
Zinc (Z), ppm	0.0065
Manganese (Mg), ppm	0.0045
Copper (Cu), ppm	0.0020

The analysis was performed in triplicate samples (n = 3) following the methods described by the AOAC (2016) 20th edition.

A significant difference ($p<0.05$) was observed in the final weight where T_2 (5% BFM) had the heaviest final weight, but statistically, comparable to quails without BFM supplementation. On the other hand, quails supplemented with 10% and 15% BFM are statistically comparable to the birds fed without BFM. The positive effect on the final weight of the Japanese quails might be attributed to the nutritive values of BFM. The proximate composition of BFM showed that it has 14.69% crude protein content, and it also contains macro and micro-minerals (Table 1). According to Beski *et al.* (2015), the crude protein content of feedstuff plays an essential role in poultry nutrition because it serves vital metabolic functions such as cell repair, body tissue development, and health maintenance. The significant effect in the final weight (FW) of quails supplemented with BFM is contrary to the findings of Atapattu and Senevirathne (2012), who reported that the inclusion of cooked and uncooked banana meal had no significant effect on the final weight of broiler chickens. However, despite the no significant effect, their findings indicate that the live weight and body weight gains of broilers fed with 10% banana fruit meal are heavier than birds without a banana meal in the diets. In the current study, banana peel in the BFM was included as a feed supplement in quail diets. It is reported that banana peelings are rich in essential amino acids (Saheed *et al.,* 2012), and the metabolizable energy range from 11.6 to 14.0 MJ/kg in the unripe and ripe peels, respectively (Tartrakoon *et al.* 1999; Diarra, 2018).

Thus, a significant effect of BFM was observed in the present feeding trial in growing Japanese quails.

Table 2. Effects of banana fruit meal on the growth performance of growing Japanese quail.

	Treatments				
Parameters (days)	T1 0%	T2 5%	T3 10%	T4 15%	p-value
Final Weight (g)					
15-28	92.00±1.00	94.00±1.00	92.00±3.00	90.00±1.00	0.119 ^{ns}
29-42	139.00±2.00^{ab}	143.33±0.58^{a}	138.00±2.65^{b}	138.00±2.65^{b}	0.021*
15-42	139.00±2.00^{ab}	143.33±0.58^{a}	138.00±2.65^{b}	138.00±2.65^{b}	0.021*
Body weight gain (g)					
15-28	50.67±3.51	53.33±4.04	51.67±3.21	50.00±5.29	0.773 ^{ns}
29-42	47.00±1.00	49.33±0.58	46.00±3.61	48.33±1.53	0.276 ^{ns}
15-42	97.67±4.51	102.67±3.79	97.67±4.62	98.33±4.93	0.497 ^{ns}
Average Daily Gain					
15-28	3.62±0.25	3.81±0.29	3.69±0.23	3.57±0.38	0.781 ^{ns}
29-42	3.36±0.07	3.52±0.04	3.29±0.26	3.45±0.11	0.279 ^{ns}
15-42	6.98±0.33	7.33±0.27	6.98±0.33	7.03±0.35	0.510 ^{ns}
Voluntary Feed Intake (g)					
15-28	206.30±2.07^{a}	205.23±0.90^{ab}	204.47± 0.76^{ab}	200.57± 3.52^{b}	0.048*
29-42	273.70±1.75	271.77± 2.45	274.07±1.12	269.77±2.66	0.116^{ns}
15-42	480.00±2.40^{a}	477.00±3.28^{ab}	478.53±1.80^{a}	470.33±4.20^{b}	0.021*
Feed Conversion Ratio (kg)					
15-28	4.09±0.33	3.86±0.27	3.97±0.27	4.04±0.37	0.825 ^{ns}
29-42	5.83±0.11	5.51±0.08	5.98±0.49	5.58±0.14	0.184 ^{ns}
15-42	4.92±0.24	4.65±0.14	4.91±0.24	4.79±0.23	0.441 ^{ns}

ns: not significant ($p>0.05$); ^{ab}Means ±SD with different superscripts in the same row differ significantly ($p<0.05$).

There is no significant difference ($p>0.05$) observed in the bi-weekly body weight gain (BWG) and average daily gain (ADG) of the Japanese quails supplemented with varying levels of BFM. Although not significant, numerical values showed that quails in T_2 (5% BFM) obtained the highest body weight gain (102.67±3.79grams), followed by T_4 (15% BFM) having 98.33±4.93grams, while T_1 (0% BFM) and T_3 (10% BFM) got the same values of 97.67±4.51grams and 97.67±4.62grams, respectively. In the voluntary feed intake (VFI), quails in T_1 (0% BFM) obtained the highest feed intake but were statistically comparable to T_2 (5% BFM) and T_3 (10% BFM), while quails in T_4 got the lowest feed intake. It is observed that quails without BFM supplementation tend to eat more to satisfy their energy requirement. Thus, birds increase their feed intake when the energy content of the diet is low (Kamram *et al.,* 2008). The decrease in the feed intake of quails supplemented with 15% BFM might be affected by the presence of anti-nutritional factors of the BFM. This finding is in line with Adeniji *et al.* (2007), who found that bananas contained low levels of anti-nutritional factors such as phytates, oxalates, and tannins. Although there is a significant effect on the feed intake, the body weight gains and feed conversion ratio were not statistically affected. No significant difference ($p>0.05$) was observed in the feed conversion ratio (FCR), but the data showed that quails supplemented with 5% BFM had better FCR than other treatments.

In quail production, the FCR is a critical metric for determining how efficiently the body of birds converts animal feed into the desired output. The FCR would mean that the lower the value, the more efficient the birds are in converting feed to live weight.

Table 3. Return Above Feed and Chick Cost (Php) per head of Japanese quails supplemented with varying levels of a banana fruit meal.

	Particular					
Treatments	Day-old quail (Php)	Feed Cost (Php)	BFM Cost (Php)	Total Operating Costs (Php)	Gross Income (Php)	RAFCC[#] (Php)
T_1 (Commercial ration + 0% BFM)	12	10.08	0.00	22.08	51.43	29.35
T_2 (Commercial ration + 5% BFM)	12	9.52	0.94	22.46	53.03	30.58
T_3 (Commercial ration + 10% BFM)	12	9.04	1.89	22.93	51.06	28.13
T_4 (Commercial ration + 15% BFM)	12	8.40	2.78	23.18	51.06	27.88

[#]All costs were shown in PhP (Philippine peso) 1 USD = 50.30 PhP

Feed consumption multiplied by current unit cost.

Total Operating Cost is the sum of prices of day-old quail, feed cost, and banana fruit meal

Gross Income was based on the average final weight of quails and 35 pesos selling price on a live weight basis.

Return Above Feed and Chick Cost was based on the gross income minus price of quail chicks, feed cost, and banana fruit meal.

Return above feed and chick cost

In terms of the return above feed and chick cost, the results showed that quails in T_2 (5% BFM) obtained the highest RAFCC with 30.58PhP, followed by T_1 (0% BFM) with 29.35PhP, T_3 (10% BFM) with 28.13PhP, while T_4 (15% BFM) got the lowest RAFCC having 27.88PhP (Table 3). Thus, banana fruit meal can be considered a valuable feedstuff vital to the feed milling industry to formulate balanced and quality feed for growing Japanese quails at a lesser cost.

Conclusion

In light of the findings, significant differences were observed in the growing Japanese quails' final weight and voluntary feed intake.

The Japanese quails in T_2 (5% BFM) had the heaviest final weight but were statistically comparable to quails without BFM supplementation. No significant differences were observed in the BWG, ADG, and FCR, but numerical values indicated that growing quails supplemented with 5% BFM had better results than quails without BFM supplementation. Moreover, 5% BFM supplementation in quail diets disclosed a bright prospect in quail production. However, a future apparent digestibility study is recommended to assess the nutrient flow and retention from the digestive sites. In conclusion, 5% BFM could be supplemented in quail diets without fear of compromising the Japanese quails' growth performance and economic traits.

Conflict of interest

The author declared no conflict of interest.

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