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Growth, Meat Characteristics and Proximate Composition of Broiler Chickens Supplemented with Fermented Fruit Juice (FFJ) and Fish Amino Acid (FAA)

Leilidyn Y Zurbano[1]*, Kent B Pitero[1], Lesley Ann C Magtibay[2], Altagracia A Silaya[3]

[1]Agribusiness Management Department, Polytechnic University of the Philippines, Lopez, Quezon Campus, [2]Hospitality Management Department, PUP Lopez Quezon Campus, [3]Business Administration Department, PUP Lopez Quezon Campus. *Corresponding Author's Email: lyzurbano@pup.edu.ph

Abstract

A study was carried out to evaluate how varying levels of Fermented Fruit Juice (FFJ) and Fish Amino Acid (FAA) influence the growth performance, meat quality traits, and proximate composition of broiler chickens. The study employed a Randomized Complete Block Design, consisting of six treatment groups, each replicated three times. In terms of weight gain, supplementation of 40 ml FFJ and FAA resulted to highest weight (1,283.80 g) and low Feed Conversion Ratio (FCR). Mortality was highest in broilers supplemented with 80 ml FFJ and FAA. For the proximate composition, the highest moisture (%) content, crude fiber and Nitrogen Free Extract (NFE) in both dry weight (DW) and fresh weight (FW) was observed in broilers supplemented with 80 ml FFJ and FAA; highest ash was seen in broilers supplemented with 100 ml FFJ and FAA. For Crude Protein (%), DW), FW and dry matter (DM) weight, the highest percentage was obtained from broilers supplemented with 40 ml FFJ and FAA. While the highest crude fat was observed in broiler supplemented with 60 ml FFJ and FAA. For organoleptic properties, no significant differences were observed in all the chicken meats for all treatments and were assessed as moderately palatable, moderately pleasant, moderately firm, moderately juicy and moderately tender. It was also rated as Moderately Acceptable by the respondents. Since, highest weight gain was observed in broilers supplemented with 40 ml FFJ and FAA, it also resulted in the highest ROI.

Keywords: Broiler, Fermented Fruit Juice, Fish Amino Acid, Proximate Composition, Sensory Evaluation.

Introduction

Modern commercial broilers are recognized as the quickest-growing and most feed-efficient poultry strains developed to date (1). Achieving optimal health and productivity in these birds depends heavily on providing diets that are properly formulated and nutritionally balanced (2). Aside from feeds, commercial vitamins and supplements are also given to help the broilers to improve weight for age, improve feed conversion rate, increase growth rate of lean muscle tissue, greater breast meat yield, and reduce body fat (3). Commonly, they are given vitamins, electrolyte, and amino acids. Inadequate vitamins and mineral intake can lead to a wide range of health issues in chickens, and in severe cases, may even result in mortality. To avoid these nutrient-related disorders, it is essential to provide a well-formulated diet that meets the birds' required levels of vitamins and minerals (2). Two natural supplements which could be given to broilers are FFJ and FAA. FFJ is an organic concoction made from sweet ripe fruits, fruits vegetables and root crops usually blended with molasses and fermented for 7 days. The extract is typically applied to the plant to promote flowering and fruit setting (4). FAA on the other hand is made from fermented trash fish and eviscerates with crude sugar or molasses. FAA contains phosphorous (2.5%) and nitrogen (90%) which is the main element component of amino acids (5). It has been said that the optimum use of synthetic amino acid improves amino acid balance and protein quality; as well they promote high lean meat production (6). Moreover, sensory analyses on chicken meat conducted showed beneficial effects of inclusion of vitamins on taste, tenderness and juiciness (7). Natural plant products, spices and other herbal plants as natural food supplements are very appealing to people who usually doubt the safety of chemically synthesized food additives and

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supplements. They also demand safe and stable products which are of superior quality (8). Generally, consumers preferred value and health in their choice of food. For the past decades, interest and research in plants, plant extracts and their derivatives phytochemicals as dietary supplements for poultry have increased (9, 10). It was also found out that spices, herbs and most of the plants contain antioxidants that prevent oxidative changes in poultry meat, thus, results to minimal off-odor production (11). As the use of antibiotics as growth promoters is prohibited, the use of nutritive strategies in improving meat quality is a fairly new approach that has emerged in animal and food science. It has been reported that nutrients supplied through the body or given when the animal is still alive, are naturally deposited and absorbed where they are needed as compared to adding compounds directly to meat after processing (12).

Commonly, poultry raisers supplemented their broilers with commercial vitamins. Thus, lead to added cost in production. However, FFJ and FAA can be used as an alternative as natural chick supplement to the broilers because of its nutrient and amino acid components. Moreover, stress in broilers is the major silent killer (13). It is often noted that poultry rarely exhibit obvious symptoms when experiencing stress. As a result, both the underlying issue and the associated losses frequently go unnoticed and unrecorded—an occurrence commonly encountered by many poultry producers (14). Since FFJ contains molasses and banana extract, it could be a good source of electrolytes for the poultry which could relieve their stress and counteract its bad effects on chickens (15).

The production of broiler chickens still has to deal with problems arising from the rising costs of feed, difficulties in growth performance, and the efficiency of management. All these negatively influence the profit margin of small- and medium-sized poultry farms. Although different feeding strategies are commercially offered, there are very few local studies done to assess the impact of such practices under actual farming conditions. Thus, it is important to fill this gap to provide the necessary information to farmers on which management options would be most efficient in terms of cost and could thus result in maintaining the profitability of the farm. In addition, PUP Lopez Campus Agribusiness Department had been involved in poultry production as part of the laboratory activities of students in Animal Science Course. So, in addition to what has been started and realizing its potential in the industry, the use of FFJ and FAA as supplements for broilers was conceptualized. The project aimed to determine the effect of FFJ and FAA on the growth, meat characteristics and proximate composition of broilers (16).

Methodology

Breed of Chicks

Broilers were purchased in Arit Poultry Supply in Lopez, Quezon. The stock consisted of Arbor Acres broilers, a strain developed by Aviagen, a leading poultry breeding company based in the United States. In the Philippines, this line is distributed by San Miguel and is widely regarded as one of the countries' preferred commercial broiler breeds (17). Only healthy day-old chicks were selected, characterized by dry and fluffy down feathers, bright and responsive eyes, active behavior, and the absence of visible defects or signs of illness. The chicks also exhibited uniformity in size and coloration and met the recommended day-old weight of below 33 grams (4).

Location and Description of the Experimental Area

The study was conducted in PUP Lopez BSAM Laboratory where the poultry house is located. It is made up of bamboo slats (floor and wall) with ventilation, elevated and oriented in an East – West direction. This is to reduce the exposure of sidewall to direct to direct sun radiation (18). The poultry house was open-sided and partly covered with curtains for regulating the airflow and light penetration. It has a total floor area of 90 ft^2. Each of the treatments in each block housed 10 chicks in 10 ft^2. The litter system was of deep type, and the rice hulls were the material used, their thickness being 8-10 cm. The temperature during the brooding period was 32-34°C in the first week and then reduced by 2-3°C weekly until the final temperature of 26-28°C was reached. Relative humidity was maintained at a level of 60-70%. The use of ceiling fans and the natural wind provided constant cross-ventilation. Clean water was always available with automatic bell drinkers at the ratio of one feeder per 10 birds. House sanitation was done under the standard biosecurity protocols, which comprised footbaths, limited access, and regular cleaning and disinfecting.

Treatment and Layout of the Experiment

This study was composed of six (6) treatments replicated three (3) times. It was laid out in Randomized Complete Block Design (RCBD) to control the environmental condition's variation and its effect on the experiment. Each of the blocks represented a certain place in the poultry house, where the micro-environmental factors (such as temperature, airflow) could slightly differ. All the treatments in each block were assigned randomly to the pens so that each treatment would be present in every block once. This design not only controlled the variability related to location but also improved the accuracy of the treatment comparisons. The following were the treatments (Table 1).

Table 1: Treatment and Layout of the Experiment

Treatment	FFJ (ml)/FAA (ml)	Water (ml)
T1 (Control)	0	0
T2	20/20	1000
T3	40/40	1000
T4	60/60	1000
T5	80/80	1000
T6	100/100	1000

Preparation of FFJ

One kilogram of sweet ripe banana was cut into chunks. The cut fruit was poured into the jar. One kg of molasses was added to the fruit. Mixture was mixed and a piece of cloth was put over the opening of the jar and secured in place with a rubber band. The jar was put in a cool, dark place and after a week, the concoction was strained and only the liquid was used as supplement.

Preparation of FAA

Fish by-products, including gills, intestines, and small low-value fish, were collected from the local market and chopped into smaller pieces to facilitate juice extraction. Approximately three kilograms of the prepared materials were placed in a basin and combined with one kilogram of molasses. The mixture was thoroughly blended to ensure that all fish components were evenly coated, which aids in the release of liquid during fermentation. The prepared mixture was transferred to a plastic pail, covered with a cloth, and secured with string. A layer of paper was placed over the top to permit limited airflow while allowing gases generated during fermentation to escape. The container was then stored in a cool, shaded area for four weeks. After about a month, the fermented liquid extract was ready and subsequently transferred into a dark-colored glass jar for storage.

Rearing of the Day-Old Chicks

Fluorescent lamps were used as the primary heat source to maintain warmth for the day-old chicks throughout both day and night. Temperature conditions in the brooding area were kept stable, with no sudden fluctuations observed during the chicks' first two weeks. However, the temperature could be adjusted based on the chick's behavior. If they are 0-1 week old, the temperature needed is 32.2 – 35.0°C, if they are 1–2-week-old, the temperature should be 29.4 - 32.2°C, if 2 – 4 weeks, temperature should be 26.7 – 29.4°C and if they are above 4 weeks, and the heat supply should be removed. They were fed intermittently rather than continuously. Research studies have shown that chicks utilize nutrients better when using intermittent feeding (4). The feeding troughs were not allowed to go empty for more than 1-2 hours. The poultry house was cleaned and dried to prevent chicks' contamination from parasites and diseases. The environment was maintained as consistently as possible, as abrupt changes in the surroundings can induce stress or discomfort in the chicks. Examples of such disturbances include removing the brooder canopy, slamming doors near the brooding area, or allowing drafts to enter. Feed and fresh water were always available. Supplements were added to the drinking water every day every night. Chicks were checked at night. Any chicks that appeared weak, deformed, or unhealthy were immediately removed from the flock and disposed of appropriately by burying.

Rearing of the Growing Stock

The broilers were sold once they reached 35 to 45 days of age. During periods of high temperature, the birds' feed intake tended to decline; therefore, their appetite was encouraged by offering wet mash or by reducing the house temperature through methods such as misting, spraying, or applying water to the roof. They were provided with fresh, clean drinking water at all times.

Feeding Management

Ten g/day of chick booster feeds was given to broilers for 0-7 days. While 60 g/day of broiler starter feeds was given for 3 weeks from 8-24 days. The broiler finisher ration was given 90 g/day for 25-35 days and starved 24 hours before culling.

Health Management

In order to prevent or control disease, vaccination was given to broilers. Commonly, vaccine is administered to broilers at day 1, day 21 and day 45. However, the chicks purchased are already vaccinated and were culled at day 35 so no vaccine was given to broilers to avoid residue.

Sanitation Management

Manure was removed every day on the ground and dried under the sun to reduce fly populations. Small landfill was also built beside the poultry house in case there is no sunlight. After every discharge of waste materials, it was covered with soil to avoid flies and smell.

For water management, the flooring was properly graded to allow excess surface water to drain away from the facility, and any low-lying areas surrounding the structure were leveled and filled to avoid water accumulation. Clean drinking water was consistently provided to minimize the risk of dysentery among the birds. Additionally, excessively high temperatures inside the poultry house—which can lead to increased water intake—were controlled through adequate ventilation. Dead birds were quickly removed and disposed. Manure and feed spills were cleaned up and disposed of immediately especially if wet (19).

Treatment Application / Vitamin / Supplements Administration

For the control treatment (T1), vitamins were given to them until a day before culling and antibiotics were given to them until day 28. The commercial vitamins were given to them every night while antibiotic was given to them every day. Twenty g of vitamin powder was dissolved in 1 gallon of water and was given to broilers ad libitum. For the rest of the treatments, FFJ and FAA solution were given to them every day during nighttime until a day before culling. It was administered ad libitum.

Data Gathered

For FAA, all the 18 amino acids were analyzed; For FFJ, vitamins such as vitamin A, D, E, K, and B complex such B1, B2, B12, folic acid and biotin; and minerals such as Ca, Zn and Mg of FFJ were determined and samples were brought to Lipa Laboratory, Lipa City, Batangas.

Initial weight was recorded, and weight was gathered weekly using a weighing scale and expressed in g. The total feed intake was calculated by multiplying the weight of each feed bag by the number of bags used, then dividing this value by the flock's combined body weight and subsequently by the total number of birds. Feed conversion ratio was determined by dividing the amount of feed consumed by the overall weight of the birds. The organoleptic properties of broiler meat were also obtained. The culled broilers were evaluated by a 50-member taste panel. Among the participants, 68% fell within the age range of 18-24 years old; Two respondents or 4 percent were aged between 25 - 38 years old; while 3 participants, equivalent to 6 percent, were in the 32 - 38 years old category; 6 individuals, comprising 12 percent, belonged to the 39-45 years old range; 4 respondents, accounting for 8 percent, fell into the 46 - 52 years old bracket; and 1 participant, or 2 percent, was aged between 53-60 years old. In terms of gender, 25 or 50 percent of the respondents were male, 21 or 42 percent were female, and 4 or 8 percent were part of the LGBTQIA+. They were instructed to rate the taste on a 1-9 Hedonic scale (20). The sensory attributes include aroma (typical chicken aroma), taste (palatability), texture (firmness), juiciness and tenderness. The chicken meat was steamed at the same time. No additives/seasonings were added. The respondents were asked to avoid eating, drinking and smoking for one hour prior to food tasting. They rated the different sensory attributes based on a Labeled Magnitude Scale. Respondents were instructed to spit out each sample after tasting it. During the 60-second interval between samples, they rinsed their mouths four times with deionized water and refreshed their palates using premium crackers (SkyFlakes).

For the proximate analysis, 500 g of meat from each treatment group were submitted to the Lipa Analytical Laboratory. Moisture, protein, crude fiber, fat, and nitrogen-free extract (NFE) were analyzed on both wet and dry bases. To assess the economic viability of incorporating FFJ and FAA as supplements in broiler production, a cost–return analysis was performed, and the Return on Investment (ROI) was subsequently calculated.

Statistical Analysis

The sample size for each treatment group was determined by the usual experimental designs employed in broiler nutrition trials. Even though a formal statistical power analysis was not done, the number of birds allocated per replication (30 birds) fulfilled the minimum requirement for recognizing biologically significant differences in growth performance and feed efficiency, which is often advocated in poultry research methodologies. The replication structure and uniform management conditions provided sufficient statistical reliability. Data on growth performance, mortality, feed efficiency, and proximate composition of the broilers were examined using a One-way Analysis of Variance (ANOVA). When significant differences were detected, the Least Significant Difference (LSD) test was applied to compare treatment means, using the Statistics for Agricultural Research (STAR) software. For the sensory evaluation of meat characteristics of broilers, weighted mean was used.

Results

Nutrient Content of FAA and FFJ

As shown in Table 2, the amino acid content of FAA (g/100 g) is 2.3728 which includes all the different types of amino acids. Based on the result, the amino acid content of FAA is much lower than the dietary amino acid (%) requirements of broilers. Among the different amino acids, methionine, cysteine, lysine, arginine and glutamine are the most limiting and considered to be important for the broilers' overall growth and performance. As discussed, the amino acid requirement of broilers decreases as the broilers' age (20). For methionine, 0.77g/100 g is needed by a 35-day old broiler; 1.06 g/100 of lysine; 0.71 g/100 g of threonine; 0.75 g/100 g of isoleucine; 0.87g/100 g of valine and 1.14 g/100 g of Arginine (21).

FFJ is made from sweet ripe fruits. It has been said that FFJ is a good source of probiotics, vitamins and minerals. For its nutrient requirements, the maximum amounts of salt (NaCl) and crude fiber (CF) in a broiler's feed should be 0.5% and 5%, respectively. The maximum amount of acid insoluble ash in broiler diets should be 2.5 percent. Greater consumption of these substances lowers feed utilization effectiveness. While accessible phosphorus in all forms of broiler rations must be at least 0.45%, calcium (Ca) and total phosphorus (P) levels should be at least 1% and 0.7%, respectively. For magnesium, the broiler requirement is 0.6 g/kg DM (22). While Ca and Zn requirement is 7.2-9.6 g/kg and 40 mg/kg (23, 24). For its vitamin requirements, Vitamin A (0.15 IU/kg), Vitamin B1 (600 mg/kg), Vitamin B2 (5 mg/kg), Vitamin B3 (15 mg/kg), Vitamin B9 (0.015 mg/kg), Vitamin B12 (0.02-0.025 mg/kg), Vitamin C (20-40 mg/kg), Vitamin D (6000 IU/kg), Vitamin E (1400 mg/kg) and Vitamin K (15 mg/kg). As shown in Table 3, Zn, Vitamin B1, E and K content of FFJ is much lower than that of the nutrient requirements of broiler though higher Ca and Mg, Vitamins B2, B3 and C were observed in FFJ. While, Vitamins A, B9 and B12 were not detected in the FFJ sample.

Growth Rate of Broilers

As shown in Table 4 and Figure 1, the weight of the broilers is lower than the standard. Many factors could be considered such as the external climatic condition since it was made sure that the internal living condition for broilers is conducive for them. Those given with 60 ml FFJ and 40 ml FAA had the highest weight and significantly different with the rest of the treatments. It was followed by those broilers supplemented with 40 ml FFJ. The broilers under the control treatment had a total gain weight of 1203 g and heavier than those broilers supplemented with 80 and 100 ml of FFJ and FAA respectively. Thus, it clearly shows that giving FFJ and FAA to broilers is comparable to the effects of commercial supplements.

Feed Intake and FCR

As shown in Table 5, feed intake is higher for broilers supplemented with 20 ml FFJ and 20 ml FAA but also higher FCR. Meaning more feeds is consumed. While those supplemented with 40 ml FFJ and 40 ml FAA (T3) had the lowest feed intake and lowest FCR meaning those broilers effectively convert the feeds into weight. It could be inferred that 40 ml FFJ and FAA are the optimum amount of organic supplements which could be given to broilers.

Mortality Rate of Broilers

A mortality rate of up to/around 1.5% during this first week is not unusual. However, as seen in Table 6, mortality of broilers for T5 reached 16.7% during the first week and 6.7% for both T4 and T6 during week 1. The result could be attributed to outside factors which the chicks got from their travel. However, mortality was also recorded in the weeks ahead until week 4 which is around 3.33% but no mortality for T6 from week 2 until they were culled. The mortality observed could be due to climatic conditions during that time since the temperature ranged from 26 to 28 while the broiler requirement is from 18 to 24 degree Celsius.

Table 2: Amino Acid Content of FAA

Amino Acid	Weight in grams (g/100g)
4-Hydroxyproline	<0.03
Alanine	0.410
Arginine	0.0120
Aspartic Acid (including Asparagine)	0.498
Cystine (sum of Cystine and Cysteine, expressed as Cystine)	0.0364
Glutamic Acid (including glutamine)	0.279
Glycine	0.166
Histidine	.0205
Isoleucine	0.134
Leucine	0.126
Lysine	0.0778
Methionine	0.0572
Phenylalanine	00610
Proline	0.0984
Serine	0.0774
Threonine	0.0749
Tyrosine	0.0262
Valine	0.218
Total Amino Acids	2.3728

Table 3: Nutrient Content of FFJ

Nutrient	Weight in mg/100 g	Method Used
Calcium	1,530.00	Atomic Absorption Spectrophotometry
Magnesium	279.67	Atomic Absorption Spectrophotometry
Zinc	5.69	Inductively Coupled Plasma (OES)
Vitamin A	ND (μgRE/100 g)	High Performance Liquid Chromatography, SOP-CHRM-024)
Vitamin B1 (Thiamine HCL)	214.66 mg/L	High Performance Liquid Chromatography, SOP-CHRM-024)
Vitamin B2 (Riboflavin)	64.31 mg/L	High Performance Liquid Chromatography, SOP-CHRM-024)
Vitamin B3 (Nicotinic Acid)	1,553.22 mg/L	High Performance Liquid Chromatography, SOP-CHRM-024)
Vitamin B9 (Folic Acid)	ND (μg/100 g)	High Performance Liquid Chromatography, SOP-CHRM-017)
Vitamin B12 (Cyanocobalamin)	ND (mg/L)	High Performance Liquid Chromatography, SOP-CHRM-017)
Vitamin C (Ascorbic Acid)	2,526.29 mg/L	High Performance Liquid Chromatography, SOP-CHRM-017)
Vitamin D3 (Cholecalciferol)	ND (mcg/100 g)	High Performance Liquid Chromatography
Vitamin E (Tocopherol)	25.04 mg/L	High Performance Liquid Chromatography, SOP-CHRM-017)
Vitamin K_3 (Menadione)	2.20 mg/L	High Performance Liquid Chromatography, SOP-CHRM-017)

Table 4: Weight Gain of Broilers 5 Weeks after Rearing

Treatment	Weight Gain (g)					
	Week 1	Week 2	Week 3	Week 4	Week 5	Total Weight Gain
T1 – 0 ml FFJ and FAA	124.80[b]	251.67[a]	242.50[b]	244.67[b]	324.07[c]	1187.71[c]
T2 - 20 ml FFJ and 20 ml FAA	143.60[a]	243.17[e]	257.51[ab]	223.82[b]	306.75[d]	1174.81[d]
T3 – 40 ml FFJ and 40 ml FAA	130.20[b]	248.17[c]	270.17[a]	232.00[b]	336.42[b]	1217.29[b]
T4 – 60 ml FFJ and 60 ml FAA	133.47[b]	249.5[b]	270.07[a]	291.43[a]	339.33[a]	1283.80[a]
T5 – 80 ml FFJ and 80 ml FAA	116.60[c]	245.28[d]	215.79[c]	231.93[b]	297.06[f]	1106.44[f]
T6 – 100 ml FFJ and 100 ml FAA	125.50[b]	250.42[b]	249.52[ab]	238.81[b]	301.69[e]	1165.90[e]
CV(%)	7.31	5.80	3.25	16.31	0.0738	.0425

Footnote: Values within the same column bearing the same superscript letter (a, b, c, ab) are not significantly different, while values with different superscript letters differ significantly at $p < 0.05$, based on the Least Significant Difference (LSD) test.

Table 5: Feed Intake and FCR of Broilers 5 Weeks after Rearing

Treatment	Feed Intake Week 1	FCR Week 2	Feed Intake Week 3	FCR Week 4	Feed Intake Week 5	FCR	Feed Intake	FCR	Feed Intake	FCR	Total Feed Intake	Total FCR
T1 – 0 ml FFJ and FAA	125.00	1.01	333.50	1.34	470.83[d]	1.74	963.81[b]	4.05	981.11[c]	3.19[b]	2874.26	2.42
T2 -20 ml FFJ and 20 ml FAA	125.00	0.87	308.50	1.28	518.51[a]	2.01	983.55[a]	4.41	1065.69[a]	3.60[a]	3001.25	2.58
T3 – 40 ml FFJ and 40 ml FAA	125.00	0.96	340.83	1.37	484.33[c]	1.79	933.00[d]	4.11	948.33[d]	2.85[b]	2831.50	2.33
T4 – 60 ml FFJ and 60 ml FAA	125.00	0.94	335.83	1.35	451.33[e]	1.67	982.83[a]	3.37	1019.17[b]	3.01[b]	2914.17	2.27
T5 – 80 ml FFJ and 80 ml FAA	125.00	1.08	320.24	1.31	506.44[b]	2.35	959.59[c]	4.20	1033.15[b]	3.61[a]	2944.42	2.68
T6 – 100 ml FFJ and 100 ml FAA	125.00	1.00	328.67	1.31	469.02[d]	1.88	909.59[e]	3.82	953.70[d]	3.21[b]	2785.98	2.39
CV (%)		7.91	8.45	11.13	10.23	18.40	9.03	16.01	8.48	15.52	7.09	9.85

Footnote: Values within the same column bearing the same superscript letter (a, b, c, ab) are not significantly different, while values with different superscript letters differ significantly at $p < 0.05$, based on the Least Significant Difference (LSD) test. Legend: FCR = Feed Conversion Ratio.

Table 6: Mortality (%) of Broilers for 5 Weeks of Rearing

Treatment	Week 1	Week 2	Week 3	Week 4	Week 5	Total Mortality (%)
T1 – 0 ml FFJ and FAA	0	0	0	1	0	3.33
T2 -20 ml FFJ and 20 ml FAA	0	0	3	0	0	10
T3 – 40 ml FFJ and 40 ml FAA	0	0	0	1	0	3.33
T4 – 60 ml FFJ and 60 ml FAA	2	0	0	1	0	10
T5 – 80 ml FFJ and 80 ml FAA	5	0	1	0	0	20
T6 –100 ml FFJ and 100 ml FAA	2	0	0	0	0	6.7

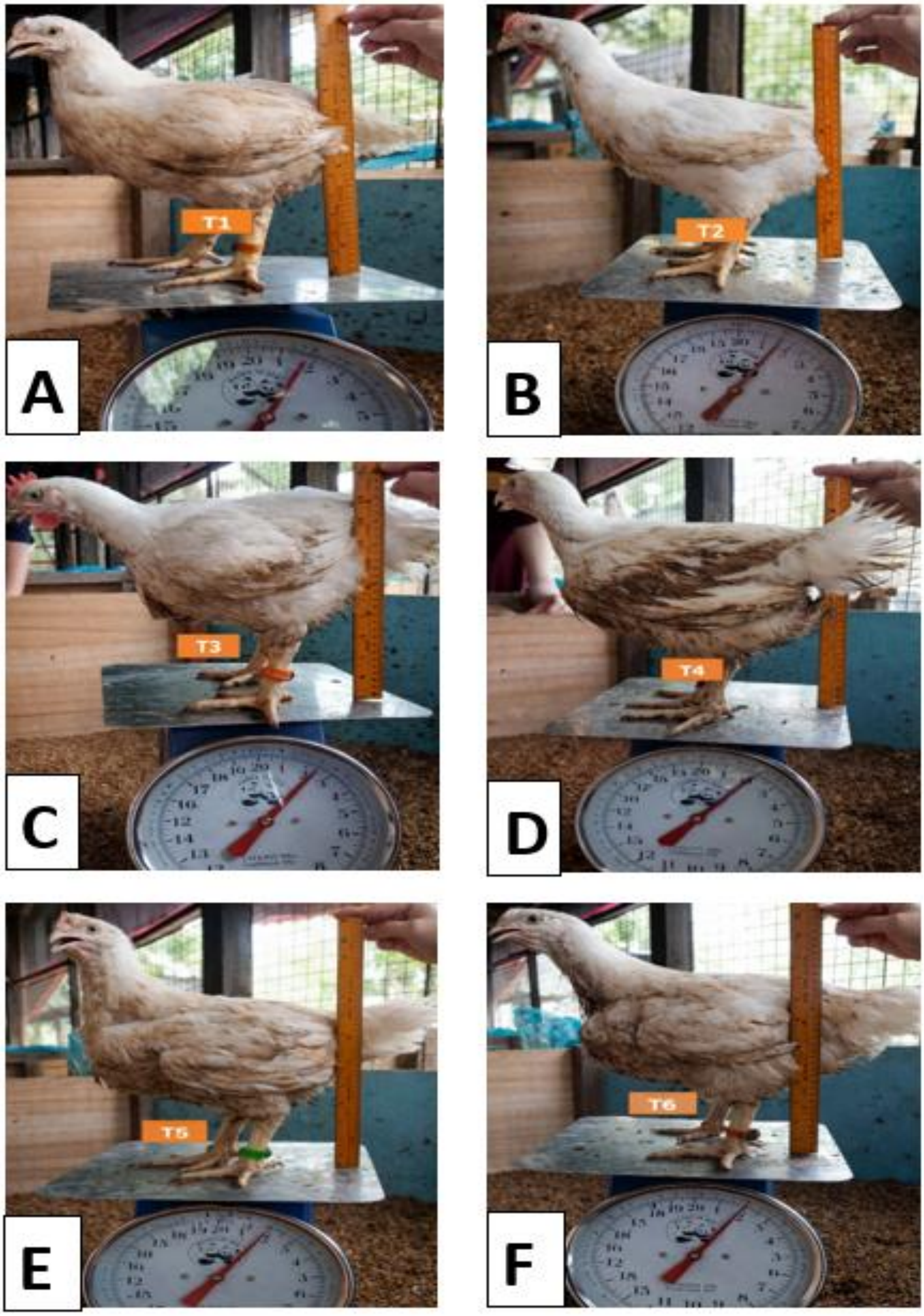

Figure 1: Broilers on Their 5th Week of Rearing (A - T1 - 0 ml FFJ and FAA; B – T2 - 20 ml FFJ and 20 ml FAA; C – T3 - 40 ml FFJ and 40 ml FAA; D – T4 - 60 ml FFJ and 60 ml FAA; E - T5 - 80 ml FFJ and 80 ml FAA and; F – T6 - 100 ml FFJ and 100 ml FAA)

Proximate Composition of Broiler Meat

Proximate analysis is used to determine the quantitative levels of key components in food, including moisture, crude protein, total fat, carbohydrates, and dietary fiber. DW is partial dehydration of the meat at 70°C, while DM is the complete removal of the moisture content of the meat. As shown in Table 7, as expected for the moisture content, all water is removed for the DM and broiler supplemented with 20 and 80 ml FFJ and FAA had the highest moisture content for both FW and DW. While, meat of broiler supplemented with 60 ml FFJ and FAA had the lowest moisture content. The DM consists of all the components of the food (crude protein, crude fiber, crude fat and NFE) except for ash and moisture. For the DM, no significant difference was observed on the FW of the meats. While, significant difference was observed on the DW of the DM wherein meat of broiler supplemented with 60 ml FFJ and FAA had the highest DM content followed by T1 (commercial vitamins) and T3 (40 ml FFJ and FAA). Ash content reflects the total mineral composition of a food sample. Determining this value is important for several reasons, including its role as a key parameter in the nutritional assessment conducted through proximate analysis.

The initial stage of getting a food sample ready for a particular elemental analysis is ashing. For the FW, the highest ash content was observed in meat of broilers supplemented with 40 ml FFJ and FAA while for the DW, highest ash content was observed in meat of broilers supplemented with 100 ml FFJ and FAA. In DM state, ash was highest in meat of broiler supplemented with 40 ml FFJ and FAA. Crude protein is a measure how much is the protein in the food. It includes nitrogen and amino acids. For the FW and DM state, no significant differences were observed but the highest crude protein was observed in those supplemented with 40 ml FFJ and FAA. Likewise, for the DW, highest crude protein was observed in the meat of broiler supplemented with 40 ml FFJ and FAA. Crude fiber analysis aims to measure the indigestible components of a food sample, particularly cellulose, hemicellulose, and lignin. These substances, which are largely present in the cell walls of plant-based foods, are resistant to digestion and are not broken down by enzymes in the gastrointestinal tract. Thus, it is also a measure of digestibility. For FW, DW and DM, broiler meat supplemented with 80 ml FFJ and FAA had the highest crude fiber content. For the crude fat, may it be in DW, FW and DM state, meat of broiler supplemented with 100 ml FFJ and FAA had the highest crude fat followed by those supplemented with commercial vitamins. Nitrogen Free Extract (NFE) represents soluble carbohydrates such as starch and sugar. Highest NFE content was obtained from the meat of broilers supplemented with 80 ml FFJ and FAA. While for the DM state, highest NFE was obtained from meat supplemented with 40 ml FAA and FFJ.

Organoleptic Properties of Broiler Meat

Table 8 shows the sensory evaluation of the organoleptic properties of broiler in terms of tastes, aroma, firmness, juiciness, tenderness and general acceptability. For the taste, all of the broilers under different treatments were rated as Moderately Palatable. The slight differences in means between treatments may not be statistically significant, but they suggest that Treatment 3 had the highest average rating for taste, followed closely by Treatments 4 and 5. However, it is important to note that the differences in means are small and may not be practically significant. Overall, the findings indicate that the respondents generally agreed that the taste of the cooked chicken was moderately satisfactory across all treatments. In terms of aroma, there does not appear to be any significant difference in the assessment of the quality of cooked chicken in terms of the aroma between the different treatments. All treatments have similar mean scores ranging from 6.58 to 6.71, which are all interpreted as Moderately Pleasant. In terms of firmness, there is no significant difference in the assessment of the quality of cooked chicken. All treatments have means that fall within the range of 7.00-7.14, with verbal interpretations of Moderately Firm. There is some variation in the assessment of the quality of cooked chicken in terms of juiciness across different treatments. However, the differences in means are relatively small and all treatments fall within the verbal interpretation of Moderately Juicy. There is also no significant difference in the assessment of juiciness between the treatments.

Table 7: Proximate Composition of Broiler Meat in DW and FW and DM

Treatment	Moisture (%)					DM		Ash			Crude Protein (%)			Crude Fiber (%)			Crude Fat (%)		Nitrogen free extract (%)		
	DW	FW	DM	DW	FW	DM	DW	FW	DM	DW	FW	DM	DW	FW	DM	DW	FW	DM	DW	FW	DM
T1 – 0 ml FFJ and FAA	22.62^{bc}	77.43^{bc}	0	77.38^{bc}	22.57																
100	6.14^{ab}	1.97	8.75^{ab}	63.74^{b}	18.88	83.30	1.40^{ab}	0.49^{ab}	2.12^{b}	8.52^{b}	2.47^{bc}	10.97^{b}	20.2^{d}	76.19^{a}	0.00						
T2 -20 ml FFJ and 20 ml FAA	39.17^{a}	77.75^{a}	0	60.83^{d}	22.03	100	4.24^{b}	1.86	6.95^{b}	50.80^{c}	18.34	83.27	1.19^{b}	0.37^{b}	1.62^{b}	4.30^{c}	1.76^{cd}	9.13^{bc}	39.46^{b}	77.67^{a}	0.00
T3 – 40 ml FFJ and 40 ml FAA	25.76^{b}	77.29^{b}																			
0	74.24^{c}	22.71	100	7.69^{ab}	2.34	10.37^{a}	69.92^{a}	18.90	83.57	0.44^{c}	0.30^{b}	1.25^{b}	2.56^{c}	1.55^{d}	3.54^{d}	27.41^{c}	76.91^{a}	1.54			
T4 – 60 ml FFJ and 60 ml FAA	13.29^{d}	77.57^{d}																			
0	86.72^{a}	22.45	100	7.68^{ab}	2.16	9.63^{ab}	61.90^{b}	18.09	80.73	1.21^{b}	0.39^{b}	1.70^{b}	13.16^{a}	3.39^{a}	15.07^{a}	8.03^{e}	75.98^{a}	0.00			
T5 – 80 ml FFJ and 80 ml FAA	42.41^{a}	77.62^{a}	0	57.61^{d}	22.39	100	4.05^{b}	1.77	8.99^{ab}	45.14^{c}	17.74	79.30	1.99^{a}	0.80^{a}	3.47^{a}	4.30^{c}	1.73^{cd}	7.50^{c}	44.53^{a}	77.94^{a}	0.60
T6 – 100 ml FFJ and 100 ml FAA	17.05^{cd}	77.29^{cd}	0	82.96^{ab}	22.54	100	8.26^{a}	2.15	9.53^{ab}	65.74^{ab}	17.91	79.73	0.81^{bc}	0.25^{b}	0.99^{b}	12.59^{a}	3.29^{ab}	14.60^{a}	12.59^{a}	65.09^{b}	0.00
CV(%)	8.75	1.44	0	3.19	4.73		22.16	17.64	11.00	3.42	4.43	2.92	18.28	25.87	25.15	12.85	12.52	10.06	6.83	2.52	

Footnote: Values within the same column bearing the same superscript letter (a, b, c, ab) are not significantly different, while values with different superscript letters differ significantly at $p < 0.05$, based on the Least Significant Difference (LSD) test. Legend: FW = Fresh Weight; DW = Dry Weight; DM = Dry Matter.

Table 8: Sensory Evaluation of Broiler Meat Characteristics

Treatment	Taste		Aroma		Firmness		Juiciness		Tenderness		General Acceptability	
	Mean	**Descriptive Interpretation**	**Mean**	**Descriptive Interpretation**	**Mean**	**Descriptive Interpretation**	**Mean**	**Descriptive Interpretation**	**Mean**	**Descriptive Interpretation**	**Mean**	**Descriptive Interpretation**
T1 – 0 ml FFJ and FAA	6.80	Moderately Palatable	6.58	Moderately Pleasant	7.06	Moderately Firm	6.63	Moderately Juicy	7.01	Moderately Tender	7.13	Moderately Acceptable
T2 -20 ml FFJ and 20 ml FAA	6.91	Moderately Palatable	6.58	Moderately Pleasant	7.00	Moderately Firm	6.89	Moderately Juicy	7.07	Moderately Tender	7.05	Moderately Acceptable
T3 – 40 ml FFJ and 40 ml FAA	7.00	Moderately Palatable	6.58	Moderately Pleasant	7.14	Moderately Firm	6.81	Moderately Juicy	7.01	Moderately Tender	7.00	Moderately Acceptable
T4 – 60 ml FFJ and 60 ml FAA	6.97	Moderately Palatable	6.60	Moderately Pleasant	7.13	Moderately Firm	7.08	Moderately Juicy	7.25	Moderately Tender	7.03	Moderately Acceptable
T5 – 80 ml FFJ and 80 ml FAA	6.93	Moderately Palatable	6.71	Moderately Pleasant	7.01	Moderately Firm	6.91	Moderately Juicy	7.05	Moderately Tender	7.13	Moderately Acceptable
T6 – 100 ml FFJ and 100 ml FAA	6.87	Moderately Palatable	6.63	Moderately Pleasant	7.01	Moderately Firm	6.68	Moderately Juicy	6.95	Moderately Tender	7.01	Moderately Acceptable
CV(%)	2.25		2.08		1.56		3.41		3.27		2.34	

No significant differences were observed among treatments ($p > 0.05$).

Table 9: Costing and Return on Investment of Broiler Chickens

Materials	Cost per Bird					
	T1 Commercial Vitamins	**T2 20 ml FFJ/FAA**	**T3 40 ml FFJ/FAA**	**T4 60 ml FFJ/FAA**	**T5 80 ml FFJ/FAA**	**T6 100 ml FFJ/FAA**
Birds	39.00	39.00	39.00	39.00	39.00	39.00
Feeds	79.38	79.38	79.38	79.38	79.38	79.38
FAA		9.71	18.86	28.29	37.71	47.14
FFJ		9.90	19.81	29.71	39.62	49.52
H2O Soluble	12.67	-	-	-	-	-
Vaccines and Medicines	1.10	1.10	1.10	1.10	1.10	1.10
Cleaning Materials	2.25	2.25	2.25	2.25	2.25	2.25
Heating	12.50	12.50	12.50	12.50	12.50	12.50
Water	2.75	2.75	2.75	2.75	2.75	2.75
Transportation	2.00	2.00	2.00	2.00	2.00	2.00
Labor	10.00	10.00	10.00	10.00	10.00	10.00
Total Cost	161.65	168.59	187.65	206.98	226.31	245.64
Harvest in kg/Bird	1.04	0.96	1.20	1.22	1.11	1.19
Revenue (Price x Harvest in Kg)	207.23	192.96	240.60	243.38	222.00	237.66
Net Profit = Revenue - Total Cost	45.58	24.37	52.95	36.41	4.31	7.98
ROI	28.20%	14.46%	28.22%	17.59%	-1.90%	-3.25%

Economic Analysis

Table 9 shows a detailed analysis of the production cost of broilers under various dietary treatments. The cost of production significantly increased due to the increasing amount of FFJ and FAA supplements added to the broiler diet. However, all other expenses remained constant as uniform conditions were maintained throughout the experimental period.

It's worth noting that Treatment T3, which received 40ml of FFJ and FAA supplements, recorded a higher net profit and net profit per kg of carcass weights compared to other treatments. The return on investment for T3 is 28.22%, which is .02% higher than treatment 1 using commercial vitamins.

Discussion

Amino acids and Vitamin supplements are two nutraceuticals needed by broilers. It is said that these offer positive pharmacological effects, such as establishing physiological health state in a normal range, preventing diseases, and consequently enhancing performance in production. They are also crucial for guarding against oxidative stress, managing the immunological system, and maintaining normal biochemical, physiological, and homeostatic processes. They also aid in providing nutrients in a balanced manner to ensure the best possible growth performance. Usually, the use of these nutritional supplements and modern poultry flocks can cut down on the use of antibiotics, which if commonly use will results in the spread of antibiotic-resistance (25). Thus, the reason for the use of FFJ and FAA.

Various nutrients have different roles in broiler and determination of it in the supplements such as FFJ and FAA is very important. Calcium is a vital mineral element, which is crucial for numerous biological activities, including intracellular signaling, enzyme activation, acid-base balance, and bone mineralization (26). It has been said that Ca is crucial in bone development of broilers and can be considered as one of the man reasons for leg abnormalities that lead to economic loss (27). According to a recent study, magnesium is one of the most prevalent divalent cations in living cells and is essential to numerous cellular functions (28). Magnesium has a role in bone calcium and vitamin D metabolism as well as the metabolism of fats, carbohydrates, and amino acids (29). Zinc is a vital mineral that broilers need and it has three key roles in the body that support biological processes: structural component, regulator, and catalyst (30, 31). Zinc is also necessary because it is a cofactor in over 240 enzymes and aids in the metabolism of nutrients including proteins and carbs, which promotes development and improved reproductive outcomes (32). Zinc can be utilized in broiler diets as inorganic zinc ($ZnCl_2$, $ZnSO_4$, or ZnO) or organic zinc (Zn protein, Zn amino acid, or Zn picolinate). The National Research Council (NRC) recommends 40 mg/kg of zinc in broiler diets. This can be supplied with either organic or inorganic types of zinc. Skin and the linings of the digestive, reproductive, and respiratory systems are examples of epithelial cells that depend on vitamin A for healthy growth, reproduction, and maintenance. Nutritional group, which is characterized by viscous exudates sticking the eyelids together, oculo-nasal discharge, and conjunctivitis, is caused by deficiencies. In more advanced cases, the mucosa of the respiratory and digestive tracts becomes necrotic and keratinized (33). Vitamin B1, thiamine, is required for healthy digestion of carbohydrates. The malnourished birds exhibit anorexia, weight loss, ruffled feathers, wing loss, and muscle paralysis. With their legs out and heads thrown back, the birds adopt a 'star-gazing' stance. Cereal grains, wheat bran, and rice polish are rich sources of it. Since riboflavin (Vitamin B2) is a component of enzyme systems, metabolism depends on it. When the bird is between the first and second week of life, the deficit results in diarrhea and "curled toe paralysis." The afflicted birds use their wings to help them walk on their hocks. Reduced egg production, higher embryonic mortality, dead in shell chicks, dwarfing, and clubbed down feathers are observed in adult birds. Vitamin B12, or cyanocobalamin, is involved in the production of nucleic acids, the metabolism of fats and carbohydrates, and the formation of methyl. All foods originating from animals include this. In broiler diets, nicotinic acid supplements ranging from 1.5 to 33 mg/kg/DM led to a rise in the birds' ultimate weight (620 g versus 221 g in supplemented chicks). Both raising carcass weight and reducing abdominal fat were successful uses of nicotinic acid and niacin, while the changes were usually not statistically significant. A 150 mg/kg nicotinic acid supplement combined with copper sulfate and chromium chloride significantly decreased the cholesterol in the broiler chicks' thigh and breast muscles. Leg problems were significantly decreased in broiler diets when nicotinic acid (6 to 33 mg/kg/DM) was added (6.3% against 12.8% in hens not getting nicotinic acid). Niacin and its derivatives are generally added to broiler diets to maximize performance in broilers (34). Folic acid is a necessary B-vitamin that hens of all ages require. It is also known as folate, vitamin B9, or folacin. While folate naturally occurs in food, folic acid, the synthetic version of vitamin B9, is found in supplements and foods fortified with fortification. Folic acid is essential for healthy brain development and has a significant impact on mental and emotional well-being. It is particularly crucial during the rapid growth of cells and tissues because it helps produce DNA and RNA, the body's genetic material. Vitamin B12, or cyanocobalamin, is involved in the production of nucleic acids, the metabolism of fats and carbohydrates, and the formation of methyl. Its absence results in decreased hatchability, poor feed utilization, and slower growth. Peak embryonic death occurs on day seventeen of incubation. There may be hemorrhages in the embryo's allantois and myotrophy of the legs. Vitamin B12 can be found in milk products, animal proteins, and fish meal (33). Ascorbic acid, another name for vitamin C, is a necessary nutrient for livestock and poultry. It is essential for maintaining the strength of their immune system. The production of collagen, a protein that gives tissues including skin, bone, and cartilage structural support, depends on the vitamin. It also functions as an antioxidant, assisting in shielding cells from harm brought on by free radicals. Ascorbic acid has been demonstrated to improve immunological function in poultry and animals, including the development of more antibodies and better functioning white blood cells. Studies have shown that ascorbic acid can also aid in lowering stress in animals, which can enhance their general well-being and immune system (35). Vitamin D supplementation is closely related to a decreased incidence of bone disorders because vitamin D is involved in various physiological processes, including the absorption of calcium and phosphorus, bone mineralization and mobilization (36). It may be possible to mitigate the negative effects of broiler heat exposure with vitamin E. In addition to potentially improving animal performance, adding 250 mg kg-1 of vitamin E to the feed can be used in areas where health issues exist or when the broilers are housed in hot, humid environments. This will also increase the nutritional value of the meat (37). 2020 Chinese study discovered that supplementing with Bacillus subtilis PB6 and vitamin K3 enhanced the growth performance of broiler chickens. Supplementation improved the shin bones' structural properties, especially in the growth period, by affecting the metabolism of calcium and phosphorus and osteogenic gene expression. Research conducted on broiler chickens in China revealed that vitamin K enhances feed efficiency and bone formation. Eight milligrams per kilogram supplementation enhanced growth performance in weeks six and seven as well as bone quality in the first three weeks following hatching. For starters, they recommend 8 mg/kg, and for grower and finisher stages, 2 mg/kg (38).

As per standard weight of broiler, birds can gain 4-5 times its weight after 7 days. Feeds consumed must also be less than its body weight (BW). For the 14th day, BW should not be less than 400-500 grams and feed consumption should not be more than 360 grams for week. For day 21, cumulative Feed Consumption should be around 1115 grams and BW of broiler should be around 850 grams. Feed consumption for week will be 575 grams. For day 28, bird BW should be around 1400 grams and particular week will be 860 grams. Cumulative Feed Consumption should be 1975 grams. For day 35, bird consumes around 1075 Gram Feed for week, and Cumulative Feed Consumption should be around 3050 grams. BW will be around 1980 Grams. All this may differ as per farm management, quality of chicks and climatic condition.

The higher weight of broilers supplemented with 40 and 60 ml of organic supplements could be attributed to the higher molasses content of the supplements. It has been said that the development of molasses for animal nutrition is a breakthrough. Molasses usually contains 76% sugar. It provides instant energy feed and better substitute for carbohydrate rich food such as grains. It has also no limitations when given to poultry in addition to the fact that it could help the food/liquid to be more aromatic and palatable. It has also been said that the broiler requires 2,000 kcal thus it could be inferred that glucose is a very important nutrient in the broiler's diet. In one recent study, it showed that molasses increased the growth performance of broilers as compared to the conventional diet. He also said that his findings on the use of molasses are promising (39). Also, given that FFJ contains banana extract and molasses, it may be a useful supply of electrolytes for poultry, reducing stress and mitigating the negative effects on broilers (40). Conversely, FAA has amino acids that are necessary for growth and will significantly affect the amount of meat produced, the feed/gain ratio, and the number of days needed to reach the right BW (41).

Similar findings were also presented where molasses was added to the drinking water of broilers and subsequently showed an increase in weight gain and consumed lesser feeds (42). In another study, specifically on the effect of fermented fish waste on the growth of chicken, 100 ml of FAA resulted to higher carcass weight (43). However, in another study, no significant differences were observed on weight gain, feed intake and feed conversion (44). Also, in one study, those fed with commercial feeds gained the highest weight (45).

The link between kg of feed consumed and kg of BW growth is known as the FCR, and it is used by the poultry industry as a performance indicator for flocks. In and of itself, the FCR is just a figure. Because a higher conversion coefficient is shown by a lower FCR, it can occasionally be difficult to interpret. Less feed is required for a flock to gain higher BW, meaning that flock is more efficient when its FCR is lower. This is significant for the chicken business because rising production costs are a result of feed costs. Producers benefit monetarily from an FCR since it maximizes energy, digestibility, and weight gain from smaller amounts of feed, hence reducing overall diet expenditures.

Mortality remains a major concern in the broiler industry, carrying significant implications not only for animal welfare but also for production economics. The welfare aspect is clear – being sick or injured to the point that death ensues is not welfare positive. On the economic side, it is also clear that it is not only the cost of bringing meat to the market, but also the overall cost of the birds bought, and number of mortalities should be considered to make sure that broiler production contributes to farm income. However, significant factors might affect its mortality like temperature and ventilation and chick quality. Generally, mortality during the first week is often related to the quality of day-old chicks, which is often outside the control of the farm. Climate change is causing a growing trend when there are extreme weather conditions; such heat waves result in losses and adversely impact the welfare of animals (40). External temps affect many broilers' internal climates that lead to heat exhaustion resulting to weight loss, lower feed consumption, slower growth rate and decline in the state of health.

The result of the study is in congruence with one study wherein the external temperature and humidity affected the growth rate of broilers (46). In one of the review articles, they stated that external environmental conditions have a major influence on the risk of mortality among broilers (47). Another related study showed that there is an increase in mortality if chickens are exposed to heat load (48). This follows studies that have shown the importance of average daily temperature in predicting high broiler mortality due to heat stress (49-53). Another related study presented that broiler chickens exposed to heat load will also reduce the daily feed intake (26).

In recent years, there has been increasing attention on the quality characteristics of food products, including poultry meat. Many consumers today are more conscious of how factors such as animal welfare influence both the safety and quality of meat, and a growing number believe that organically produced foods offer better sensory attributes. and report that they "taste better" (48). Consumers considered the taste and quality of meat the most (54). They often ask how animals grow old, if it's healthy or not. The demand for meat from free-range broiler chickens was increasing in several countries as they believe that they are of the best quality. However, scientific literature believes that the differences of chickens may vary for how their environment affects them. It depends on how nutrients come into their bodies. It was supported by one study where materials made from animals, including chicken meals, are commonly used in industrial broiler production techniques (55). Animal feed manufacturers are under growing pressure to create alternative protein sources that are more morally and environmentally responsible, like insect meals, without sacrificing the taste or quality of the meat (56). Also, after achieving mass broiler production, emphasis is now being placed on improving meat quality by changing the variety of broiler meat characteristics. Regarding the nutritional quality of broiler meat, primary processing and further processing have come under scrutiny. Large differences in rigor mortis completion rate and meat quality among birds may be caused by genetic variation. the sensory quality of cooked meat was affected by non-phosphate and low-salt solution marinating more so than flavor and aftertaste. It had a bigger effect on the textural quality of cooked breast meat than thighs and drumsticks (57). In terms of aroma where there is no any significant difference in the assessment, this is related to this study. After 24 days of preservation, a sensory study of the samples showed that a combined 3% extract of cinnamon and cloves gave the samples acceptable sensory attributes. These results demonstrate that packing chicken meat in modified atmospheric packaging without oxygen and coating it with 3% mixed clove and cinnamon extract extends the meat's shelf life for samples from 4 days to 24 days. These pooled extracts and enhanced atmospheric packing boosted the usability and organoleptic qualities of chicken meat (58). Meat flavor is largely influenced by the presence of saturated and unsaturated fatty acids. When meat is exposed to heat, the unsaturated fatty acids undergo oxidation, beginning with the formation of hydrogen peroxides. These compounds then break down through free-radical reactions, producing aldehydes, unsaturated alcohols, ketones, and lactones—key contributors to meat aroma. As a result, the overall aroma profile of meat is shaped by its fat content, the specific fatty acids present, and the location of fat within the muscle tissues (7). In terms of firmness, there is no significant difference in the assessment of the quality of cooked chicken. All treatments have means that fall within the range of 7.00 - 7.14, with verbal interpretations of Moderately Firm. Broilers have traditionally been the most popular variety of chicken consumed worldwide because they are an economical and dependable source of high-quality protein (57). It has been determined that texture is the main determinant of consumer satisfaction with cooked meat. Texture characteristics of cooked breast meat samples from both conventionally reared broilers and chicks that had been caponized and fed modified feed. Furthermore, the need for animal-based protein from the pet food industry presents the broiler industry with an opportunity to repurpose undervalued co-products, which may provide more earnings than rendering processes. Rigidity increased with increasing hydrocolloid concentration in dried treats, whereas stiffness decreased and flexibility improved in treats cooked under pressure (59). However, hydrocolloids increased the water activity of dried meals while maintaining the pH and water activity of raw or pressure-cooked snacks. Dehydrated snacks are more moisturizing than raw or pressure-cooked ones due to hydrocolloids' varied effects on moisture content (58).

A study comparing how seven trained panelists perceived juiciness during chewing revealed considerable differences in their ratings during the early phase of mastication (under 10 seconds) and again toward the later phase (beyond 20 seconds) (60). These inconsistencies were linked to variations in individual chewing patterns (61). The findings suggest that asking panelists to report their juiciness perception only after the first 10 seconds of chewing may help minimize variability in juiciness scores when evaluating cooked chicken breast meat.

In one study, although the samples had a reduced flavor of chicken, they had a strong aroma of chicken (56). Larvae-fed samples showed greater metallic fragrance and aftertaste values, albeit these values were modest and unlikely to be perceived by consumers. All samples were assessed tender; fishmeal-fed samples were evaluated to be mealier than larvae-fed samples, with the control being intermediate. The samples, with the exception of those fed to the larvae, which had greater maintained juiciness values, did not have a prolonged juiciness while having a substantial initial juiciness.

Based on the findings on the cooked chicken meat's appearance, there is some variation in the mean scores for the assessment of the quality of cooked chicken across different treatments. And there is no significant difference in the assessment of the quality of cooked chicken among the different treatments.

In one study, supplementation of different kinds of bio-organic supplements affected the attributes of the meat of broilers (62). However, no significant differences were obtained for the taste, tenderness, and overall acceptability of the meat of broilers which implied that the supplementation of the different kinds of bio-organic supplements did not affect the meat taste, tenderness, and overall acceptability of broiler.

The market for chicken meat has grown dramatically over the past few decades due to its low cost, good nutritional profile, and versatility for further processing. The poultry business is expected to continue expanding in the future, according to current estimates and projection studies. The genetic selection utilized to produce fast-growing broilers in response to this escalating demand has resulted in a variety of spontaneous, idiopathic muscle abnormalities as well as enhanced vulnerability to stress-induced myopathy. These muscular aberrations affect the quality of fresh and processed foods in a variety of ways because breast meat from people with significant pectoral myopathy is commonly rejected due to its unsightly appearance. Additionally, meat that is pale, mushy, and exudative like this has a low processing ability due to its decreased capacity to hold water, soft texture, and pale hue (57). This indicates that adding these supplements had a positive impact on the production of broilers. The use of amino acids in bird nutrition reduces nitrogen loss during protein metabolism, resulting in lower ammonia excretion and improved growth performance (63). Amino acid supplementation promotes the production of cecal butyric acid and total short-chain fatty acids, which enhances growth, development, and feed conversion efficiency and improves immunity (19).

Furthermore, as per the table, Treatment 5 and Treatment 6 had significantly lower net profits than other treatments. This was due to the increased cost of FFJ and FAA supplements, affecting their profitability. Overall, it can be concluded that adding FFJ and FAA supplements can significantly impact the production cost and profitability of broilers. Treatment T3, which received the optimum amount of supplements, recorded the highest net profit, indicating that the right balance of supplements can lead to maximum profitability.

Conclusion

Generally, the use of FFJ and FAA as supplements for broilers has various effects on broilers. Depending on the use, if aiming for higher weight gain, crude protein and ROI, the use of 40 ml FFJ and FAA is recommended. For organoleptic properties, chicken meat was moderately acceptable by the evaluators regardless of the treatment. Higher concentrations (80 ml and 100 ml FFJ and FAA) led to negative ROI. Nevertheless, the use of FFJ and FAA supplementation on broilers is still recommended and comparable to the effects of commercial vitamins. Broiler farmers are encouraged to use the feeding method that showed better growth and efficiency in real-world conditions. Keeping the temperature stable, especially during brooding period is highly recommended because even small changes can have a big effect on growth rate. The use of the same biosecurity measures all the time is suggested to lower death rates and make things more consistent. Checking the feed conversion ratio (FCR) once a week is also recommended so that the manner of feeding will be changed right away. There should also be enough space, air flow, and cleanliness to get the most out of any dietary change. The results provide useful evidence from the field that can help farmers and industry professionals choose management strategies that fit their production goals. The study offers pertinent insights; however, it is constrained by the sample size and the utilization of a singular production cycle. The environmental conditions were unique to the study site and may vary among farms. Furthermore, the lack of formal power analysis limits the statistical generalizability of the results. Subsequent research may incorporate larger sample sizes, multiple cycles, and inter-farm comparisons to enhance the reliability and applicability of findings.

Future studies might investigate the long-term effects of the treatments on the economy, such as cost-benefit analysis in different market situations. Research that includes various housing systems, climatic conditions, and genetic strains may yield more generalizable results. Looking into how nutrition, health management, and environmental control work together could help improve broiler production strategies even more.

Abbreviations

BW: Body Weight, DM: Dry Matter, DW: Dry Weight, FAA: Fish Amino Acid, FCR: Feed Conversion Ratio, FFJ: Fermented Fruit Juice, FW: Fresh Weight.

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Author Contributions

Leilidyn Y. Zurbano: conceptualized the research, wrote the methodology, did the review of related literature, statistically analyzed the data, interpreted the data, did most of the manuscript writing, Kent B. Pitero: oversaw the experiment, did the data collection, interpreted FCR results, Lesley Ann C. Magtibay: contributed to literature review, wrote the results, wrote the discussion in sensory evaluation, Altagracia A. Silaya: contributed to literature review, wrote the results, wrote the discussion in economic analysis.

Conflict of Interest

The authors declare no potential conflicts of interest.

Declaration of Artificial Intelligence (AI) Assistance

The authors declare that no artificial intelligence (AI) tools were used in the preparation and writing of this manuscript.

Ethics Approval

The study was approved and obtained Ethics Clearance from the University Research Ethics Committee.

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