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. FEEDING VALUE OF AZOLLA (*Azolla sp.*) MEAL IN BROILER DIETS

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ABSTRACT

This study was conducted to determine the nutritive and feeding value of different levels of azolla meal as component of broiler diets. Specifically, it aimed to: a) determine the nutrient composition of azolla meal; b) evaluate the effects of different levels azolla meal as component of broiler diets in terms of growth performance, and dressing percentage; c) evaluate the effects of azolla meal on the organoleptic characteristics of baked broiler meat; and, d) assess the economy of azolla meal as component of broiler diets.

Five dietary treatments were used in the feeding trial. Three levels of azolla meal (5, 10 and 15%) served as components of Diets II, III and IV, respectively. Diet 1(no Azolla meal) and Diet V (Commercial Broiler Feed) served as positive and negative control diets, respectively.

The dietary treatments were arranged in a Completely Randomized Design (CRD), replicated thrice with ten birds per replication. The Randomized Complete Block Design (RCBD) was used in the organoleptic evaluation.

Dry matter recovery of azolla was 5.42%. Complete proximate analysis revealed that azolla meal contained 10.6% crude protein, 0.90% fat, 0.23.70% fiber, 19.60% moisture, 0.50% ash, and 44.70% NFE. Energy determination revealed GE content of 2904 cal/g, while mineral analysis revealed 1.6% Ca and 0.3 % P contents.

Average initial weights of the experimental birds were statistically similar in all treatments, while the final weight differed significantly between azolla-fed and control diet-fed birds.

The feed consumptions of birds were similar on the first week of rearing but highly significant differences were noted during the succeeding weeks until the termination of the study. The same observation was also noted in the FCR of birds given the different dietary treatments where birds in Diet V outperformed those in the other dietary groups with a value of 1.77 as compared to those birds given Diets I, II,III and IV with FCR values of 2.05, 2.12, 2.31, and 2.56, respectively.

In terms of absolute value, experimental birds fed with commercial feed gave the highest dressing percentage of 78.49 percent while those in Diet IV (15% azolla meal) gave the lowest absolute dressing yield at 77.13 percent.

Experimental birds fed with 0% azolla meal gave the lowest feed cost per unit gain in weight and the highest return above feed cost. Experimental birds given the 15% azolla meal (Treatment IV) incurred the highest feed cost per gain-in-body weight which translated to lowest returns above feed cost.

Baked meats from broilers fed with different levels of azolla meal were moderately desirable in terms of color and appearance. Statistical analysis revealed significant differences in juiciness, tenderness, flavor and aroma, and general acceptability. Baked meats of broilers from the two control diets were moderately

tender and juicy while the baked meats from the treated treatments were slightly tender and juicy. The flavor and aroma, and the general acceptability of baked meat from all the treatment were moderately like and accepted except the baked meat taken broilers fed with commercial feed which is like slightly and accepted.

With all these findings and information, it could be deduced azolla meal could be safely incorporated in the diets of broilers. Broilers given 5% AM in the diet performed similarly with those in the control diets in terms of the production, economic, dressing yield and organoleptic evaluations.

Introduction

Human population in the Philippines is rapidly increasing. According to the National Statistics Office (2010), the country has a population of about 92,337,852 million Filipinos. With this growing population, it is expected that sizable number of people will suffer from malnutrition if supply of prime food commodities would not be sustained. Majority of them would be deprived of food, especially that of meat and eggs if food production will not be sustained. Promoting and developing more agricultural industries which could be good sources of adequate and nutritious foods is of prime importance to cater the immediate needs of the growing population.

The poultry industry is ranked as one of the most profitable agribusiness ventures in the Philippines. It provides income with the shortest possible time as well as nutritious meat and eggs for human consumption (Ramos, 1995). Recently, the broiler industry has developed to a highly integrated poultry production system. Large numbers of farms are now established in the different parts of the country creating employment opportunities.

Despite these benefits and advantages, the poultry industry is beset with problems that affect its steady growth. Some of these problems include high costs of feed ingredients, parasites and diseases, marketing; and, competition with humans for the same food resources.

To address such problems particularly on high cost of feed ingredients, search for alternative ingredients for livestock and poultry feed formulations are of prime importance. Use of alternative ingredients however, must result in reduced feed cost and increased production efficiency. Furthermore, these alternative ingredients must not be directly used for human consumption to prevent competition with animals.

A promising solution is the continuous search on the utilization of the different non-conventional by-products, with high nutritive values. One of the identified possible alternative feed ingredients is azolla (*Azolla sp.*).

Objectives

In general, the study was conducted to determine and evaluate the nutritive and feeding values of varying levels azolla meal in the diet on the growth performance of broilers.

Specifically it has the following objectives:

1. To determine the nutritive composition of azolla meal;

2. To determine the effects of various levels of azolla meal in the diet on gain in body weight, feed consumption, and feed conversion ratio, and slaughter yield/dressing percentage of broilers;

3. To determine the organoleptic characteristics of the baked meat from broilers fed with varying levels of azolla as to color and appearance, tenderness, flavor, juiciness, and general acceptability; and,

4. To evaluate the economy of using azolla meal as component of broiler diets as to cost of feed per unit gain in weight, and income above feed cost.

MATERIALS AND METHODS

Materials

Cages, feeding troughs, drinking troughs, brooding litters, heaters, weighing scale, record books as well as the experimental stock and ration were made available during the conduct of the study.

Methods

Preparation and furnishing of experimental cages. Each experimental cage was fabricated to accommodate ten birds. Fifteen cages were fabricated with each cage accommodating five treatments with three replications.

Cages were fabricated out of local materials following the recommended floor space allowance for broilers. Brooder heaters were properly installed. Feeding troughs and drinking troughs were properly cleaned, washed and disinfected using commercially available disinfectants.

Collection and processing of the test ingredient. Azolla plants were collected from rice paddies and other bodies of water. These were placed in nets and washed in flowing water to remove foreign materials that adhered to the plants.
After collection, the plants were thinly spread in fishnet mats for sun-drying. All weeds, snails and other foreign particles that adhered to the leaves and roots were removed. Occasional stirring was done to facilitate faster drying. Sun-drying was done for at least three days or until the plants became brittle to be ground in a hammer mill to produce the azolla meal.

Analysis of the test feed ingredient. Two hundred twenty-gram samples of azolla meal were taken to the Central Feed Laboratory, Bureau of Animal Industry, Quezon City, Philippines for complete proximate analysis, gross energy, calcium and phosphorus determination. The result of the analysis is presented in Table 1. It served as basis in the formulation of the different experimental broiler diets.

Table 1. Proximate, energy and chemical analysis of azolla meal

Parameter	Analysis (%)	Method used
Protein	10.60	Kjeldahl (Tecator)
Fat	0.90	Soxhlet (AOAC)
Fiber	0.50	Weende (AOAC)
Moisture	19.60	Oven drying (AOAC)
Ash	23.70	Ignition (AOAC)
NFE	44.70	By difference
Gross Energy, cal/g	2904.00	Calorimetry (Isoperibol)
Calcium	1.60	Titrimetry
Phosphorous	0.30	UV-Vis

Experimental animals, design and treatments. One hundred fifty heads of day-old broiler chicks were distributed to five treatments in three replications following the randomization procedures of a completely randomized design (CRD). The treatments are as follows:

Treatment 1 (D_1) - No azolla meal (Positive control)

Treatment 2 (D_2) - 5% azolla meal

Treatment 3 (D_3) - 10% azolla meal

Treatment 4 (D_4) - 15% azolla meals

Treatment 5 (D_5) - commercial feed (Negative control)

Experimental diet formulation. Straight broiler mash diets containing 19-20% crude protein were formulated (Table 2). Ground yellow corn, rice bran (D1), soybean oil meal, copra meal, fish meal (Peruvian), limestone (ground) molasses, salt, multivitamin, azolla meal and cellulase were used in diet formulation. Except Diet V (Negative control) which was already mixed upon purchase, all other diets (Diets I, II, III, and IV) were mixed at Jamiko's Feed Mill, Payawan, Lamut, Ifugao.

Table 2. Ingredient composition and calculated analysis of the experimental diets

Ingredients	Diet 1 with 0% Azolla Meal	Diet 2 with 5% Azolla Meal	Diet 3 with 10% Azolla Meal	Diet 4 with 15% Azolla Meal	Diet 5 Commercial Feeds
Azolla meal	0.00	5.00	10.00	15.00	Certified
Yellow corn	57.00	52.10	48.25	44.00	Ingredient
Soy bean meal	21.00	21.00	19.80	19.35	composition
Copra meal	9.00	9.00	9.00	9.00	
Fish meal	4.00	4.00	4.00	4.00	
Rice bran D1	4.00	4.00	4.00	4.00	
Molasses	2.85	2.85	2.85	2.85	
Limestone	1.05	0.81	0.65	0.55	
Salt	0.30	0.30	0.30	0.30	
Mycotox	0.01	0.01	0.01	0.01	
Multivitamins	0.25	0.25	0.25	0.25	
Methionine	0.02	0.02	0.02	0.02	
Avemix (enzyme)	0.00	0.02	0.02	0.02	
TCP	0.5	0.64	0.61	0.65	
TOTAL	100	100	100	100	

Except azolla meal, Diet 1 or the positive control contained the same feed ingredients as the other experimental diets. With the exception of Diet V, the other diets were formulated isocaloric and isonitrogenous with approximate energy contents ranging from 2700-2900 and protein contents of approximately 20% (Table 3), respectively.

Table 3. Calculated proximate, chemical and energy content analyses of the test diets.

Ingredients	Diet 1 No Azolla Meal	Diet 2 5% Azolla Meal	Diet 3 10% Azolla Meal	Diet 4 15% Azolla Meal	Diet 5 Commercial Feeds
Crude protein, %	19.96	20.10	19.85	19.73	Certified
Crude fiber, %	4.31	4.15	3.99	3.83	Chemical
Fat, %	3.94	3.81	3.71	3.60	Analysis
Ca, %	0.86	0.86	0.85	0.86	
P, %	0.42	0.43	0.43	0.42	
ME kcal/kg	2,889	2,824	2,774	2,712	
Ash, %	3.91	5.05	6.08	7.16	
Lysine, %	1.02	1.05	1.06	1.08	
Methionine, %	0.38	0.39	0.39	0.39	

Management Procedures

Preparation of the cages. Cages and equipment were disinfected ten days before the start of the study. The cages were fabricated using local and commercial materials such as bamboo, lumber and mesh wire following the recommended floor space requirement for broilers.

Empty feed sacks were used to cover the open sides of the cages to maintain and conserve heat inside the brooders. Top portions of the cages were covered with fish nets to prevent the entry of predators.

Layers of old newspapers at 3-4 in thick were used as litter materials to maintain heat. These were checked and changed regularly to maintain dryness and prevent ammonia build-up.

Litter materials were gradually removed from the 15th until the 19th day of brooding. Brooders were provided with correct brooding temperature and light from a 50-watt electric bulb. The height or position of the bulbs was adjusted accordingly, depending upon the behavior of the chicks inside the brooder cages.

Upon arrival, the experimental birds were randomly distributed in identical fabricated cages at the poultry project of Ifugao State University (IFSU) Main Campus, Nayon, Lamut, Ifugao, Philippines. Birds were immediately given dextrose and electrolytes via the drinking water to replenish lost energy during transport. Feed was given two hours after chicks-in. At five days old, the chicks were immunized against Newcastle disease (B_1 strain) by intraocular method. Vitamin-mineral preparations were also given to the chicks

to increase their resistance against stress and diseases. Birds in all treatment groups were reared up to 35 days of age.

Experimental Procedures

Feeding. The experimental diets were weighed before given to the chicks. The diets were placed on wide-brimmed tray feeders during the first five days of the birds' life. Later, feeds for all treatment groups were placed in automatic bell-type feeders. Feeds were given *ad libitum* and drinking water was made available at all times.

Data Collection

Body weight. The initial body weight of the chicks was taken as the group weight for each replication prior to distribution to respective treatment groups. Weekly weight was monitored and recorded to determine growth trend that maybe attributed to the dietary treatments. Weekly weighing was done before feeding the broilers in the morning. Final weight was taken at the termination of the study. The difference between the initial and final weights represented the final gain in weight of the broilers at the end of the experiment.

Feed consumption. Actual feed intake was recorded as the cumulative feed consumption taken as the difference between total weekly feed allocation and the unconsummated amount from the said allocation at the end of the feeding period. Feed consumption was recorded and was summarized on weekly basis.

Feed conversion ratio (FCR). This is the amount of feeds needed to produce a unit gain in weight. This was determined by dividing the average feed consumed by the average gain in weight of the broilers.

The economy of using the diets. The economic benefit of the experimental diets was based on the computed average cost of feed per kilogram gain in body weight and the income over feed cost. The cost of feed per unit gain in weight was determined as the product of unit feed cost (₱/kg) and the feed conversion ratio of broilers.

Slaughter yield. Two finished broilers (one male and one female) were randomly taken from each treatment as samples. The sample birds were fasted for a 12-hour period before slaughter to facilitate evisceration and ensure non-contamination of the carcasses with visceral contents. Birds were conventionally bled; feathers were plucked after broilers were subjected to proper scalding temperature of 102^{o}F. The shank and the head were cut-off after evisceration.

The following data were collected:

Body weight. Liveweight of the samples was recorded after fasting prior to slaughter. Dressed weight was taken after bleeding, cleaning, evisceration and removal of the head and shanks. Live and dressed weights of the birds were used in determining the dressing percentage.

Dressing percentage. The average dressing percentage was computed using the formula.

$$ADP = \frac{ADW}{ALW} \times 100$$

Where:

ADP is the average dressing percentage
ADW is the average dressed weight
ALW is the average live weight

Giblet weight. The combined weight of the gizzard, liver, spleen, pancreas and heart was recorded as giblet weight.

Statistical tool. All data were analyzed using the analysis of variance (ANOVA) for a Completely Randomized Design (CRD). Significant differences among treatment means were compared using the Least Significant Difference Test (LSD).

Organoleptic Evaluation

Sampling and preparation of test materials. Five dressed broilers were used to represent the five dietary treatments in the sensory evaluation.

Dressed carcasses were washed, evenly rubbed with 10 g of salt and simultaneously baked with a constant oven temperature of 325^{o}F. Except salt, no flavoring was added to ensure the meat's natural taste during the evaluation. The baked meat were chopped into 1-inch cubes and placed in properly labeled saucers.

***Organoleptic evaluation*.** Thirty consumer panelists evaluated the baked meat samples in terms of color, tenderness, flavor, juiciness and acceptability using the 9-point Hedonic Scale. Each panelist was provided with a copy of a score card purposely designed to facilitate the evaluation. Fifteen selected IFSU employees with cooking skills and expertise composed the first panel of evaluators. The panelists have no artificial teeth, non-smokers and non-alcoholics. The other group of 15 panelists composed of senior major in Foods students from College of Home Science and Technology.

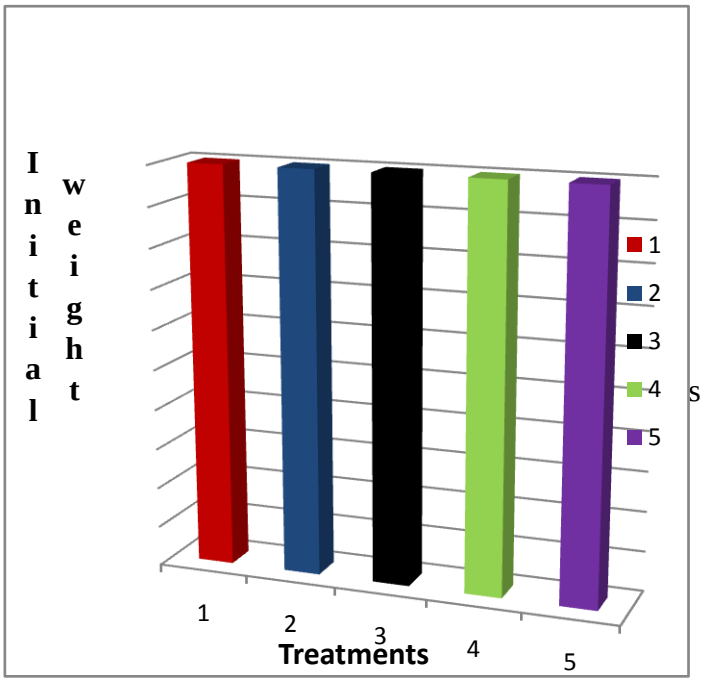
Statistical tool. All data were analyzed using the analysis of variance (ANOVA) for a Randomized Complete Block Design (RCBD) with five treatments and 30 replications. Significant differences among treatment means were compared using the Least Significant Difference Test (LSD).

RESULTS AND DISCUSSION

Body weight

Initial weight

No significant difference was noted on the initial weight of the experimental birds (Figure 1). Average weight ranged from 44 to 45 g. Similar initial weight suggests the homogeneity of the experimental birds as an important requirement for a completely randomized experiment. Similarities in initial weight of the broiler chicks also indicate batch uniformity which warrants complete randomization in the distribution of the experimental birds to the respective dietary treatments. Said uniformity insures the absence of external factors that might influence the performance of the birds aside from the dietary treatments.



Weekly gain in weight.

Highly significant variations on weekly gain in weight were observed among the experimental birds during the first and two weeks (Table 4). Commercial diet (Negative control)-fed broilers had the highest weight gain. It was also observed that the peak of weight gain of broilers fed with different diets was during the fifth week or the final week of rearing (Table 1). This observation indicates that the birds have not attained their highest gain in weight because its trend was still increasing. In this regard, there is a probability that higher weight gains could be achieved by broilers fed with different dietary group should feeding period had been extended for a period of time.

A decreasing trend in weight gain was noted as inclusion level of azolla meal increased.This suggests that like all monogastrics, broilers are less capable in digesting cellulosic materials like azolla meal. Increased fiber contents and increasing levels of azolla meal in the broiler diets (Table 3) could be the reason for this decreased gain.

Poorer weight gain of birds fed with a diet containing 15% azolla meal could be attributed to the lower feed intake and consequently a reduced metabolizable energy intake. This observation was noted specially during the first two weeks of feeding where most of the ingredients left in the feeding troughs were basically azolla meal. This means that broilers refused to consume higher inclusion rates of azolla meal in the diet possibly of its higher fiber contents. It has been reported that birds on high energy diets consume more metabolizable energy thus resulting in a significant increase in body weight gain (Alalade, *et al*., 2006). Previous reports made by Basak *et al.* (2002) and Beckangham *et al.* (1978) have implicated high levels of ADF (30.08) and lignin (28.24) as the main factor limiting the efficient utilization of azolla meal by monogastric animals.

Table 4. Weekly gain in body weight (g) of broilers fed with azolla (*Azolla sp.)* meal in the diet

TREATMENT	WEEKS				
	1	2	3	4	5
I – Positive control	079	158	192	325	455
II – Diet w/ 5% AM	080	157	181	372	386
III – Diet w/ 10% AM	078	142	166	327	358
IV – Diet w/ 15% AM	073	114	167	257	353
V – Commercial feed	103	172	221	428	553
F-TAB	21.51 **	10.68**	5.82*	17.56**	11.70**
CV,%	5.36	7.88	8.75	7.66	10.09

** Significant at 1% level * Significant at 5% level

Final weight. Highly significant variations were noted in the final weight of the experimental birds (Table 5). Commercial diet (Negative control)-fed birds had the heaviest final weight of 1476 g. These outweighed the birds fed with azolla meal-containing diets. Comparison among means showed that broilers fed with 5% azolla meal performed comparatively with birds fed with the No azolla meal diet. This supports the findings of Alalade and Iyayi (2006) and Basak e*t al.* (2002) that broilers fed with 5% azolla meal diet had better gain in body weight. Broilers fed with

15% azolla meal diet had the lowest final weight of 0.963 g. This led to the idea that increasing the level of azolla meal in broiler diet tended to decrease final weight.

Table 5. Average final weight (g) of broilers fed with different levels of azolla (*Azolla sp.)* meal in the diets

TREATMENT	AVERAGE FINAL WEIGHT (g)
I (Positive Control)	1209.00[b]
II (5% Azolla Meal)	1174.00[b]
III (10% Azolla Meal)	1072.00[c]
IV (15% Azolla Meal)	963.00[d]
V. (Negative Control)	1476.00[a]
MEAN	1.18
CV, %	10.09

Feed Consumption

Weekly feed consumption.

No significant variations on average weekly feed consumption of the experimental broilers were noted during the first week (Table 6). Changes however were observed from the 2nd to the 5th and final week when highly significant differences in feed consumption were noted.

Table 6. Average weekly feed consumption (g) of experimental birds fed with different levels of azolla meal (*Azolla sp.)* in the diets.

TREATMENT	WEEKS				
	1	2	3	4	5
I (Positive Control)	165	293	472	675	874
II (5% Azolla Meal)	166	294	473	675	878
III (10% Azolla Meal)	167	293	470	667	877
IV (15% Azolla Meal)	158	290	470	662	875
V. (Negative Control)	166	301	490	725	930
F-TAB	2.44[ns]	32.17[**]	11.82[**]	423.81[**]	43.42[**]
CV,%	26.50	0.45	0.90	0.31	0.72

** Significant at 1% level [ns] Not significant

Birds fed with commercial broiler (Negative Control) diet consistently consumed more feeds compared to those that were fed with the other diets from the 2nd to the last week of

the experiment as shown in Table 9. This conforms to the result of the study conducted by Bestat and Morenton (1985) as cited by Basak (2002) that azolla affected the palatability of the feed resulting in reduced feed consumption.
The lesser feed consumption of birds fed diets with azolla meal indicated that palatability may have been adversely affected by its inclusion. The relatively high amount of azolla meal observed in the left-over of the experimental birds justifies this observation.

Cumulative feed consumption. Consistent with weekly feed consumption, commercial broiler diet-fed broilers had the highest average cumulative feed consumption (Table 7). Broilers fed with the positive control and Azolla meal-containing diets consumed significantly lesser feeds than birds that were fed with the commercial broiler (negative control) diet.
This conforms to the result of the study conducted by Bestat and Morenton (1985) cited by Basak (2002) that azolla affected the palatability of the feed resulted to the reduced feed consumption. The lesser feed consumption of birds observed in the azolla meal-treated diets or the unconsumed azolla meal in the ration indicates the low palatability of azolla meal.

Table 7. Average cumulative feed consumption (g) of broilers fed with different levels of azolla meal *(azolla sp.)* in the diets.

TREATMENT	MEAN
I (No Azolla Meal Diet, Positive Control)	2478.00[b]
II (5% Azolla Meal)	2487.00[b]
III (10% Azolla Meal)	2474.00[bc]
IV (15% Azolla Meal)	2464.00[bc]
V (Commercial Broiler Mash, Negative Control)	2615.00[a]
GRAND MEAN	2504.00
CV, %	0.34

** Significant at 1% level

Feed Conversion Ratio

Weekly feed conversion. The weekly and final feed conversion ratio is presented in Tables 8 and 9, respectively. Experimental broilers fed with commercial feed (Diet 5) had the least amount of feed to produce a kilo of meat as evidenced by the lowest value of the average FCR of 1.77. It was followed by broilers in Treatments I, II, III and IV with an average FCR 0f 2.05, 2.12, 2.31 and 2.56, respectively. This means that broilers given Diet 5 (Commercial Broiler Feed) converted feeds into weight gains more efficiently when compared to the birds in the other dietary groups.
Statistical analysis on the feed conversion ratio revealed there were highly significant differences among experimental birds fed with the experimental diets. This finding

explains that the ability of broiler to convert feeds into meat depends on the composition and structure of the feeds. This conforms to the idea cited by Bakingham *et al*. (1978) that growth rate is attributed to the high level of ADF (acid detergent fiber) and lignin contained by azolla meal, which is the factor limiting the efficient utilization in monogastric animals. This also confirmed the findings of Castillo *et al.* (1981) that monogastric animals like broilers are inefficient in digesting cellulosic materials like the high fiber contents found in the azolla meal.

This notion was verified because broilers fed with Diet V and Diet I converted their feeds more efficiently than that of experimental birds in the other treatment which were fed with different percentages of azolla meal in the diets. However, comparative performance of experimental broilers given Diet II (with 5% azolla meal) with that of the positive control revealed no significant difference. This suggests that inclusion rate of azolla meal should not be higher than 5% in the diet of broilers similar with the finding of Alalade *et al.* (2006). This also agree with Basak *et al.* (2002) which noted that ducks fed with more than 15% azolla meal in the diet increased the feed conversion ratio

Table 8. Average weekly feed conversion ratio of experimental birds fed with different levels of azolla meal (*Azolla sp.)* in the diets

TREATMENT	WEEKS				
	1	2	3	4	5
I (Positive Control)	2.08	1.88	2.48	2.09	1.92
II (5% Azolla Meal)	2.08	1.87	2.62	1.82	2.32
III (10% Azolla Meal)	2.13	2.06	2.85	2.07	2.51
IV (15% Azolla Meal)	2.30	2.56	2.83	2.59	2.49
V. (Negative Control)	1.64	1.76	2.22	1.70	1.68
F-TAB	35.53**	10.95**	4.02*	10.17**	4.52*
CV,%	3.50	8.18	8.67	9.07	13.65

** Significant at 1% level * Significant at 5% level

Table 9. Final feed conversion ratio of experimental broilers fed with different levels of azolla (*Azolla sp.)* meal in the diets

TREATMENT	MEAN
I (No Azolla meal, Positive Control)	2.05[b]
II (5% Azolla Meal)	2.12[b]
III (10% Azolla Meal)	2.31[c]
IV (15% Azolla Meal)	2.56[d]
V (Commercial Broiler Mash, Negative Control)	1.77[a]
GRAND MEAN	2.16

CV, %	4.17

** Significant at 1% level

Slaughter yield

The slaughter yield of the experimental birds is expressed in terms of dressing percentage with and with out giblets. The dressing percentage is the result of the average dress weight over the average live weight multiplied by 100. The average weights of giblet on the other hand, include gizzard, liver, heart, and pancreas.

Dressed weight and dressing percentage

The average dressing percentage of the experimental birds is shown in Table 10. The dressing percentage ranged from 77.14 to 78.45. The analysis of variance revealed that there was no significant effect of azolla meal in terms of the dressing percentage. The average live weight of the sample birds range from 1,000g to 1,520 g while the average dress weight ranged from 770g to 1,200 g.

Table 10. Summary table on the dressing percentage (%) of finished broilers fed with different levels of azolla (*Azolla sp.)* meal as component of the diets

TREATMENT	AVERAGE LIVEWEIGHT (g)	AVERAGE DRESSED WEIGHT (g)	DRESSING PERCENTAGE (%)
I (Positive Control)	1270	990	77.92
II (5% Azolla Meal)	1230	950	77.36
III (10% Azolla Meal)	1120	870	77.44
IV (15% Azolla Meal)	1000	770	77.14
V (Negative Control)	1520	1200	78.45
GRAND MEAN			77.63
F TAB	0.74 ^{ns}		
CV %	1.27		

^{ns} Not significant

Average weight of giblets

Table 11 reflects the average weight of giblets as affected by the different levels of azolla meal ranged from 120g to 130 g. Weight of giblets from birds fed with 15% azolla meal was heavier although no significant difference was noted compared to those in the other treatments.. It was also observed that there were no lesions found in the different organs. This finding showed that the levels of azolla meal incorporated in the diet in broilers had no detrimental effects on the growth performance of the experimental birds so it is therefore feeding broilers up to 15% inclusion of azolla meal in the diet is still safe.

Table 11. Summary table on average weight of giblets (g) of broilers fed with different levels of azolla meal (*Azolla sp.)* component of the diets.

TREATMENT	REPLICATION			TOTAL	MEAN
	1	2	3		
I (Positive Control)	115	130	125	370	123.33
II (5% Azolla Meal)	125	125	120	370	123.33
III (10% Azolla Meal)	130	120	132	380	126.67
IV (15% Azolla Meal)	130	135	135	400	133.33
V. (Negative Control)	125	110	125	360	120.00
GRAND TOTAL				1880	
MEAN	115	130	125	370	125.33
F TAB	2.045 ^{ns}				
CV%	13.86				

^{ns} Not significant

Economic Efficiency of the Diet

Return above feed cost. The average return above feed cost from broilers fed with different diets is presented in Table 12. It was observed that broilers in Treatment I had the highest return above feed cost with an absolute value of ₱2,218.84. This was followed by broilers in Treatments II, III, V and IV with RAFC values of ₱2,078.50, ₱1,738.01, ₱1,628.54 and ₱1,376.87, respectively. This implied that as higher inclusion rate of azolla meal in the diet was done, the higher feed cost was attained. This implied that cost of feed mixtures in the treated diets was affected by the cost of processing the azolla meal. The cost of processing was ₱38.34 which was higher than the price of the major raw feed ingredients except that of fish meal.

Table 12. Return above feed cost (₱) of broilers fed with different levels of azolla *(Azolla sp.)* component of the diets

ITEM	TREATMENT				
	I	II	III	IV	V
Total liveweight, kg	37.59	36.57	33.495	30.198	45.624
Sales of broiler, PhP	3,759	3,657	3,349.60	3,019.80	4,562.40
Total feed consumed, kg	74.225	74.093	74.013	73.766	77.995
Cost per kilogram, PhP	20.75	21.30	21.77	22.73	28.00
Cost of feeds, Php	1,540.16	1,578.50	1,611.59	1,642.93	2,183.86
Return above feed cost	2,218.84	2,078.5	1,738.01	1,376,87	1,628.54

Assumption

1. Selling price at 100.00/kg live weight
2. Include cost of collection and processing of azolla meal which are itemized as follows:

1. Collection of azolla plants (PhP 100/man-day for 5 days)	500.00
2. Drying of azolla plants (PhP 50/ man-day for 3 days)	150.00
3. Transportation cost (Fuel)	100.00
4. Milling fee	100.00
TOTAL	**₱850.00**

Cost of Azolla meal per kg (₱850.00/ 22.17 kg) ₱38.34

Cost of feed per unit gain in weight. Highly significant variations were noted in the cost of feed per kilogram gain in weight (Appendix Table 30). Comparison among means showed that Treatment I (0% AM) incurred the least feed cost per kilogram gain in weight compared to those in Diets II, (5% AM), III (10% AM) IV (15% AM) with mean value of ₱42.52, 45.21, 50.35, 58.26, respectively. Broilers in the Diet V (commercial feed) attained ₱49.62 costs of feed per kilogram gain in weight which was higher when compared to Diet II. However, this was lower than that of Treatments III and IV.

The significantly lower CFG incurred in Diet I (0 % AM) was attributed to the lower unit cost of the feed, better feed conversion and heavier final weights. Broilers in Treatment IV which contained the highest percent of azolla meal in the diet incurred the highest CFG due to the poor feed conversion and the high cost of azolla meal. This is in contrast with diet V, which despite the higher costs of feeds it attained a lower CFG due to better feed conversion ratio and final weight. This implies that inclusion of azolla meal higher than 5% in the diet has no beneficial effects in terms of the growth performance and profit.

Organoleptic Evaluation

Color and appearance. The color and appearance of baked meat from test broilers fed with the different treatments groups were not significantly affected by the diet. Scores of panelists from samples in all treatment groups ranged from 7.27 to 7.60 as shown in Table 13. No significant difference was noted. Panelist agreed that samples in all the treatment have moderate color and appearance.

Table 13. Hedonic Mean Score of baked broiler meat fed with different levels of azolla meal

Dietary Treatment	MEAN SCORES				
	Color and Appearance	Flavor and Taste	Tenderness	Juiciness	Acceptability
I	7.57	7.13	7.33	7.00	7.27
	Moderately desirable	Moderately desirable	Moderately tender	Moderately juicy	Like Moderately
II	7.27	7.23	7.07	6.90	7.03
	Moderately desirable	Moderately desirable	Moderately tender	Slightly juicy	Like Moderately
III	7.60	7.60	7.00	6.77	7.63
	Moderately desirable	Moderately desirable	Moderately tender	Slightly juicy	Like Moderately
IV	7.53	7.43	6.80	6.17 Slightly	7.50
	Moderately desirable	Moderately desirable	Slightly tender	juicy	Like Moderately
V	7.50	6.37	7.63	7.10	6.03
	Moderately desirable	Slightly desirable	Moderately tender	Moderately juicy	Like Slightly
F-TAB	ns	*	*	*	**
CV, %	9.34	17.45	12.84	15.93	13.25

ns Not significant * Significant at 5% level ** Significant at 1% level

Flavor and taste. The flavor and aroma scores of samples from all treatment groups range from 6.37 to 7.60 (Table 13). Qualitatively, this score is described as slight to moderately desirable. Panelist agreed that samples taken from Treatment III had moderately desirable flavor and taste while samples in Treatment V were categorized as having slightly desirable flavor and taste. Comparison among means showed that there were no significant differences in terms of flavor and taste of samples among the diets that contained azolla meal including those in the positive control. However, highly significant differences were noted when these were compared to samples taken from Diet V.

Tenderness. Tenderness scores ranged from 6.80 to 7.63 (Table 13). Based on the Hedonic scale, this range of scores was equivalent to slight to moderately tender. Samples from Treatment IV were judged as slightly tender while the rest of the samples taken from the different dietary treatments were noted to be moderately tender. Comparison among means shows that samples taken from Diets III and IV were noted to be significantly different when compared to those samples in Diet V which were evaluated as moderately tender. Samples taken from Diets I and II and were also evaluated as moderately tender, however, no significant variation was noted when these were compared with samples taken from Diet V.

Juiciness. Meat samples in this parameter were rated with scores ranging from 6.17 to 7.10 (Table 13). Highly significant differences were observed among treatment means of samples taken from the different dietary groups. Panelist agreed that samples taken from Treatments II, III and IV were slightly juicy while those samples taken from the control treatments (Diets I and V) were moderately juicy.

General acceptability. General acceptability scores of baked meat ranged from 6.03 to 7.63 (Table 13). Based on the scores, panelist agreed that all the baked meat samples taken from the different dietary treatments were liked moderate except those samples taken from Treatment V which was liked slightly. Sample baked meat from Treatment III which contains 10% percent inclusion of azolla meal had the highest percent of acceptability. This observation shows that general acceptability of meat could be enhanced if broilers are fed with azolla meal.

Other Observations

Health and vigor of the birds. In general, the experimental broilers were all healthy throughout the duration of the study as indicated by the absence of mortality. They were all active and exhibited prominent red eyes. However, there were early symptoms of coccidiosis as manifested by watery and bloody-like color of some of their manure. Medication using a sulfa drug was immediately administered for three consecutive days to address it and said signs stopped.

***Feeding behavior*.** It was observed during the first week of brooding that birds given azolla meal-treated diets selectively picked the common ingredients leaving the azolla meal in the feeding troughs. However, on the last two weeks of feeding, it was observed that broiler in treated diets consumed their ration faster than those given the control diets.

***Feathering and pigmentation*.** It was observed that most of the birds in Treatments III and IV have well developed or thicker feathers than those of Treatments I, II and V. It was also observed that broilers in Treatments II, III and IV exhibited yellowish shanks and beaks color as compared to the creamy white of those in the control diets. This may be due to the presence of Vitamin A in the azolla meal-treated diets which might be a contributory factor to this observation.

***Fecal matters*.** It was observed that fecal discharge from broilers in Treatments II, III, and IV have colors of slight to dark black as compared to the light brown manure of broilers given the two control diets.

SUMMARY, CONCLUSION AND RECOMMENDATIONS

Summary

This study was conducted purposely to generate information on the use of azolla meal (AM) in broiler diets. It was also conducted to determine the nutritive and feeding value, economics of using AM as component to broiler diets.

Specifically, this study was carried out to achieve the following objectives a) to determine the nutrient composition of azolla meal; b) to evaluate the effects of azolla meal as component of broiler diets in terms of gain in weight, feed consumption and feed conversion ratio; c) to determine the slaughter yield of broilers in terms of dressed weight with and without giblets; d) to evaluate the effect of AM on the organoleptic characteristics of baked broiler meat in terms of color and appearance, tenderness, juiciness, flavor and general acceptability; and, to assess the economy of AM as component of broiler diets in terms of return above feed cost and cost of feed per unit gain in weight.

In order to attain the above mentioned objectives, the study was categorized into three experiments namely; feeding trials, slaughter yield and organoleptic evaluation.

The feeding trials were conducted for 35 days duration. One hundred fifty day-old chicks (Marcials strain of broiler) were used as experimental birds. Five dietary treatments were used in the feeding trials. Diets II (broiler diet with 5% azolla meal) Diet III (broiler diet with 10% azolla meal) Diets IV (broiler diet with 15% azolla meal) while Diet I (broiler diet with 0% azolla meat) and Diet V (commercial feed) served as positive and negative control diets, respectively. The control diets served as references for evaluating the nutritive value of the different levels of azolla meal as component of broiler diets.

The dietary treatments were arranged in a Complete Randomized Design (CRD). Each dietary treatment was replicated thrice with ten experimental birds per replication. On the other hand, Randomized Complete Block Design (RCBD) was used in the Organoleptic Evaluation. The analysis of variance (ANOVA) was used in the statistical analysis of the data. Significant differences among treatment means were compared and analyzed using the Least Significant Difference (LSD) Test.

The results of the study are summarized as follows;

1.0 Feeding Trials

1.1 The final weight of experimental birds ranged from 0.963 to 1.476 kg;

1.2 Analysis of variance show that highly significant differences on the final weight;

1.3 The average final gain in weight ranged from 0.353 to 0.553 kilogram. Highly significant differences on the gain in weight of birds in the dietary treatments were observed. The birds given the control diets outweighed those in the azolla meal-treated diets. However, gain in weight of birds in Treatment II (5% azolla meal) was statistically similar to those in Treatment

I (positive control). This finding opened up the possibility of using 5% azolla meal in the diet of broilers.

1.4 No significant variations were noted on the average weekly feed consumption on the first week of feeding. Highly significant variations on feed consumption were noted during the succeeding weeks of feeding. The average cumulative consumption ranged from 2.464 to 2.615 kilograms;

1.5 The average feed conversion ratio ranged from 1.77 to 2.56. Highly significant difference on the FCR was noted. Birds given control diets performed better in terms of FCR than those in the azolla meal-treated diets;

1.6 Dressing percentage and the weight of giblets of broilers in the different treatment groups were noted to be not significant. The dressing percentage ranged from 77.13 to 78.45 percent while the weight of giblets ranged from 0.12 to 0.13 percent;

1.7 Return above feed cost of broilers decreases with increasing percent inclusion of azolla meal in the diets. Treatment IV (15% AM) incurred the lowest return attributed with the high cost of azolla meal and the inefficiency of broilers to convert azolla meal into meat; and,

1.8 The inclusion of cellulase in the azolla meal-treated diets did not substantially affected the performance of broilers in terms of growth and profitability parameters.

2.0 Organoleptic Evaluation

2.1 Baked meat from broilers fed with different levels of azolla meal in the diet were as good in color and appearance, tenderness, juiciness, flavor and aroma and general acceptability as those of the control diets. These were all rated moderately desirable in color and appearance, slightly to moderately tender, slightly juicy moderately desirable in flavor and aroma and like moderately in general acceptability.

Conclusion

The results of the study revealed that the azolla meal diets have nutritive and feeding values. However, the broilers fed with different levels of azolla meal treated with cellulase in the diet did not performed better than those in the control diets in terms of the growth parameters such as gain in weight, feed consumption, and feed conversion ratio. In terms of profitability, the birds given the control diets have higher income from sales when compared to those in the azolla meat treated with cellulase diets. The higher unit cost of azolla meal (collection and processing) and the cost of cellulase made the diets more expensive thus lower income was realized.

The dressing percentages of broilers taken from the azolla meal treated cellulase diets were comparable with those in the control diets. However, higher yield was

attained by birds give the control diets because of the lower cost of feeds per unit gain in weight it utilized.

` The results of the organoleptic study revealed that azolla meal treated with cellulase has no effect on organoleptic characteristic of broiler meat evaluated.

Recommendations

From the results and findings of the study, the following recommendations are made.

1. Perform digestibility study using azolla meal in broilers;
2. A complete nutrient composition analysis of azolla meal in order to provide clearer information of its nutrient composition. This will better enlighten researchers and prospective users on the merits of its use not only for monogastric but also for ruminants animals;
3. Consider another feeding trial using azolla meal treated with cellulase in crumble form. This is based on the observation that during the initial week of feeding, azolla meal was less consumed by broiler chicks; and,
4. A study of the same conducted during the hot season to compare nutrient composition of azolla during this period and evaluate growth as well as profitability parameters of broilers.

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