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Growth Performances and Carcass Characteristics of Broiler Chickens Fed Akasya [*Samanea Saman* (Jacq.) Merr.] Pod Meal

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ABSTRACT

Akasya pods are seasonally abundant and are good sources of protein and energy and have been considered as an alternative feed source for livestock. This study was conducted to determine the effects of feeding Akasya pod meal (APM) on the growth performances and carcass characteristics of broiler chickens. Three hundred straight-run 7-day-old Cobb broiler chicks were randomly allocated to five dietary treatments containing 0%, 0.5%, 1.0%, 2.5%, and 5.0% APM following a completely randomized design. Each treatment was replicated 10 times with 10 birds per replicate. The digestibility of nutrients was also evaluated to determine the effect of different levels of APM on the efficiency of nutrient digestion in broilers. Broilers fed APM level at more than 1.0% had lower body weights and body weight gains, but feed intake, feed conversion ratio, livability, and carcass characteristics were not affected by increasing levels of APM. The digestibility of crude protein (CP), crude fiber (CF), nitrogen free extract (NFE), ether extract (EE), and energy were the same in broilers across treatments. Increased income over chick and feed cost (IOFCC) was generated from broilers fed diets with 0.5% APM, but progressively declined as APM level in the diet was increased. In conclusion, APM can be used in broiler diets at inclusion levels up to 1.0% wherein growth performance and carcass characteristics were optimum in broilers and income generated was improved at 0.5% level.

***Keywords:** Akasya pod, broilers, nutrient digestibility, performance, unconventional feed source*

INTRODUCTION

In poultry production, about 70% of the total cost can be attributed to feed cost (Banson *et al*. 2015). Any attempt to improve commercial poultry production and increase its efficiency needs to focus on the use of locally available new ingredients (Kamalzadeh *et al*., 2008) that can reduce the competition that exists between human and poultry for conventional ingredients and reduce feed cost (Girma *et al*. 2011). Alternative feed ingredients open an opportunity to lower feed cost. However, indigenous feed ingredients in developing countries are often underutilized, wasted, or inefficiently used due to poor characterization of chemical components. Akasya tree [*Samanea saman* (Jacq.) Merr.] is widespread in the Philippines. A mature Akasya tree can yield 500-600 kg pods annually which are commonly fed to ruminants (Rath *et al*., 2014). It has been observed that Akasya pods are used as feed supplement in concentrates for both livestock and poultry (Flores, 2002).

Wide ranges of values were reported from various countries on the nutrient composition of akasya pods. On DM basis, an akasya pod contains 12.83%-31.32% crude protein (CP), 1.30%-17.56% ether extract (EE), 11.78%-28.14% crude fiber (CF), 44.38%-81.79% nitrogen free extract (NFE), and total phosphorus (P, total) of 0.18%-0.90% (Anantasook & Wanapat, 2011). Acacia species, however, contains high polyphenolic compounds and fiber (Mokoboki *et al*., 2013). In addition, akasya pods contains tannins which can make complex compounds with proteins, sugars, nucleic acids, and minerals (Ukoha *et al*., 2011; Saxena *et al*., 2013) that may reduce the bioavailability of nutrients leading to poor performance. According to Flores (2002) and Staples & Elevitch (2006), akasya pods contain 4.0% of condensed tannin, while Angeles *et al*. (2013) observed that the pods contain 16.42% tannins.

Titration feeding study is important to determine the optimum level of APM without deteriorating the performance of animals. Inclusion rates of akasya pods have been evaluated in boilers by Hagan *et al.* (2016) as replacement for soybean meal and fishmeal and recommended that inclusion of akasya pods should be 20 g per 100 kg of broiler diets for improved growth rate and higher profit margin. Moreover, studies by Barcelo *et al.* (2013) and Hagan *et al.* (2016) in broilers starting on days 21 and 28, respectively, showed no effects on broiler performance even though the experimental diets were not formulated to be isocaloric and isonitrogenous. The aim of this study is to determine the effect of feeding different levels of APM formulated to be isocaloric and isonitrogenous, on growth performances, carcass characteristics, nutrient digestibility, and diet economics of broilers from starter to finisher stages.

MATERIALS AND METHODS

Feeding Trial

Three hundred 7-day-old group-brooded broiler chicks were randomly allocated to five dietary treatments with 0%, 0.5%, 1.5%, 2.5%, and 5.0% Akasya pod meal (APM). Each treatment was replicated 10 times with 10 birds per replicate. Fallen whole, ripe, and clean Akasya pods were oven-dried at 105ºC for 24h and were ground to pass through a #20 Tyler mesh. Chemical analysis of Akasya pods is presented in Table 1. Ingredient composition and calculated nutrient analysis of starter and finisher diets containing different levels APM are presented in Tables 2 and 3, respectively. The experimental diets were formulated to meet or exceed the minimum nutrient requirements set by PHILSAN (2010).

The experimental broilers were housed in battery cages with stocking density of 1.0 bird sq. ft^{-1}. Starter diets were given from days 8-28 while finisher diets

Table 1. Chemical analysis of Akasya pods

Nutrient[1]	Percent in APM
Dry matter	88.70
Crude protein	15.37
Neutral detergent fiber	42.86
Ether extract	1.95
Cellulose	9.77
Hemicellulose	10.53
Phosphorous	0.76
Tannin	16.42

[1]All nutrients are expressed in % dry matter basis except for the dry matter which is in % fresh basis

Table 2. Ingredients and nutrient content (as fed basis) of starter diets containing different levels of Akasya pod meal (APM)

Ingredients	APM level, %				
	0	0.5	1	2.5	5
Yellow corn	53.96	53.72	53.47	53.09	52.85
Soybean oil meal	33.11	33.11	33.11	32.95	32.46
Akasya pod meal	0	0.5	1	2.5	5
Rice bran	7.5	7.5	7.5	6.39	3.3
Crude coconut oil	1.31	1.33	1.36	1.5	1.79
Copra meal	0.56	0.28	0	0.01	1.01
Limestone	1.47	1.47	1.47	1.47	1.47
Monodicalcium phosphate	1.18	1.18	1.18	1.18	1.21
Iodized salt	0.35	0.35	0.35	0.35	0.35
DL-methionine	0.06	0.06	0.06	0.06	0.06
Choline chloride 50%	0.15	0.15	0.15	0.15	0.15
Vitamin premix*	0.12	0.12	0.12	0.12	0.12
Mineral premix**	0.13	0.13	0.13	0.13	0.13
Mold inhibitor	0.05	0.05	0.05	0.05	0.05
Anti-coccidia	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100
Calculated Nutrient Content:					
Metabolizable energy, kcal/kg	2900	2900	2900	2900	2900
Crude protein, %	20.7	20.7	20.7	20.7	20.7
Ether extract, %	4.7	4.7	4.7	4.7	4.7
Crude fiber, %	3.47	3.5	3.53	3..64	3.86
Calcium, %	0.87	0.87	0.87	0.87	0.87
Total phosphorus, %	0.81	0.81	0.81	0.8	0.78
Avail. phosphorus, %	0.44	0.44	0.44	0.44	0.44
Lysine, %	1.1	1.1	1.1	1.1	1.1
Met + Cys, %	0.72	0.72	0.72	0.72	0.72
Tannin, %	0	0.08	0.16	0.41	0.82

*Per kg vitamin premix contains: Vitamin A (10,000,000 IU), Vitamin D3 (2,000,000 IU), Vitamin E (20,000 IU), Vitamin K3 (750mg), Vitamin B1 (500mg), Vitamin B2 (3,500mg), Vitamin B6 (3,000mg) Vitamin B12 (12mg), Niacin (25,000mg), Pantothenic Acid (10,000mg), Folic Acid (500mg), Biotin (50mg), Antioxidant (25,000 mg), Carrier (+mg)
**Per kg mineral premix contains: Iron (115,000mg), Manganese (50,000mg), Iodine (850mg), Selenium (150mg), Zinc (50,000mg), Copper (10,000mg), Carrier (+mg).

Table 3. Ingredients and nutrient content (as fed basis) of finisher diets containing different levels of Akasya pod meal (APM)

Ingredients	APM level, %				
	0	0.5	1	2.5	5
Yellow corn	53.48	53.34	53.92	54.07	55.9
Soybean oil meal	31.4	31.29	31	30.75	29.7
Akasya pod meal	0	0.5	1	2.5	5
Rice bran	10	9.77	8.95	7.2	3.41
Crude coconut oil	1.37	1.4	1.37	1.7	2.14
Limestone	1.07	1.07	1.07	1.07	1.07
Monodicalcium phosphate	1.88	1.83	1.89	1.91	1.98
Iodized salt	0.3	0.3	0.3	0.3	0.3
Choline chloride 50%	0.15	0.15	0.15	0.15	0.15
Vitamin premix*	0.12	0.12	0.12	0.12	0.12
Mineral premix**	0.13	0.13	0.13	0.13	0.13
Mold inhibitor	0.05	0.05	0.05	0.05	0.05
Anti-coccidia	0.05	0.05	0.05	0.05	0.05
Total	100	100	100	100	100
Calculated Nutrient Content:					
Metabolizable energy, kcal/kg	2900	2900	2900	2900	2900
Crude protein, %	20	20	20	20	20
Ether extract, %	5	5	5	5	5
Crude fiber, %	3.51	3.55	3.55	3.6	3.6
Calcium, %	0.82	0.82	0.82	0.82	0.82
Total phosphorus, %	0.97	0.96	0.96	0.96	0.91
Avail. phosphorus, %	0.59	0.59	0.59	0.59	0.59
Lysine, %	0.93	0.93	0.93	0.93	0.93
Meth + Cys, %	0.64	0.64	0.64	0.64	0.64
Tannin, %	0	0.08	0.16	0.41	0.82

*Per kg vitamin premix contains: Vitamin A (10,000,000 IU), Vitamin D3 (2,000,000 IU), Vitamin E (20,000 IU), Vitamin K3 (750mg), Vitamin B1 (500mg), Vitamin B2 (3,500mg), Vitamin B6 (3,000mg) Vitamin B12 (12mg), Niacin (25,000mg), Pantothenic Acid (10,000mg), Folic Acid (500mg), Biotin (50mg), Antioxidant (25,000 mg), Carrier (+mg)
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were provided from days 29-42. Feed and water were provided at all times. Vaccination against New Castle Disease was done on days 7 and 21. Feed intake and mortality were recorded daily. Broilers were weighed on days 7, 28, and 42. After slaughtering, the dressing percentage was determined.

Carcass Characteristics

On day 42, one male and one female birds from each replicate were randomly sampled, dressed, and chilled overnight. Dressing percentage, cut up yield, and sizes of cuts were determined. The lean, fat, and bone compositions of the whole leg and breast retail cuts were also recorded. Breast samples were wrapped in aluminum foil and steamed until the internal temperature reached 160°C.

Digestibility Trial

On day 35, three birds from each treatment were randomly selected and transferred to individual cages. The first three days of the metabolism trial served as the adjustment period. On day 38, collection of excreta was done for three consecutive days. The amount of feed offered and refused was recorded during the collection period. Plastic trays were installed under each cage to facilitate total collection of excreta. Feathers and scales were removed from the collected excreta. The samples of excreta were oven-dried at 70°C until constant weight. The dried excreta samples from each bird collected for three days were pooled, weighed, and ground to pass 0.5 mm screen and were subjected for proximate analysis and gross energy determination.

The percentages of digestible nutrient values were determined following the formula of Roxas, (2006) wherein;

Coefficient of digestibility (%)=
[(Nutrient intake in feeds - Nutrient in excreta) / Nutrient intake in feeds] × 100
% Digestible nutrient =
(Coefficient of digestibility × Nutrient of feeds) / 100

Feed and excreta samples were analyzed for subjecting proximate fiber fractions, energy as well as phosphorus and calcium contents following the procedures AOAC (2005) and Van Soest & Robertson (1985).

Statistical Analysis

All data for growth parameters, carcass characteristics, and nutrient digestibility were subjected to analysis of variance (ANOVA) in a completely randomized design (CRD) using SAS (SAS Institute, 2012). Comparison of treatment means was done using Tukey's HSD test. Statistical significances and tendencies were set at $P \leq 0.05$.

Economic Analysis

The cost of feeds, acquisition and preparation of APM and return from sales of finished broilers were computed to determine the income over feed and chick cost (IOFCC) which was calculated using the following formula (Magpantay *et al*., 2013):
Income over feed and chick cost =
[(Average wgts of broilers, kg) × (Price per kg live weight of broiler)] – [(Price of day-old chicks) + (Total feed consumed) × (Price of feed)]

RESULTS

The level of crude fiber in the diet increased as the level of Akasya pod meal (APM) was increased (Table 4). Body weight and body weight gains after 42 days were greater in broilers fed 0%, 0.5%, and 1% APM wherein broilers fed 0% had the greatest body weight and weight gain (Table 5). Broilers fed 2.5% and 5.0% APM had lower body weights and weight gains. Broilers fed 5.0% APM had the lowest body weight and weight gain after 42 days. Moreover, feed consumption, feed conversion ratio, and percent livability of broilers were not affected by feeding different levels of APM (P>0.05). In addition, dressing percentage with and without giblets, sizes of cuts, lean, fat, bone composition of the whole leg and breast retail cuts of broilers did not differ (P>0.05) among treatments (Table 6).

Broilers fed diets with 0%, 0.5%, and 1.0% APM were observed to have greater digestible CP coefficients while broilers fed diets with 2.5% and 5.0% APM had lesser digestible coefficients in both CP and crude fat (EE). Inclusion of APM beyond 1.0% in the diet significantly reduced (P<0.05) the digestibility of CP and EE. However, there was no difference (*P*>0.05) on the digestible nutrients in increasing levels of APM in broilers diets (Table 7).

Based on the prices of feed ingredients during the conduct of the study, unit cost of feeds decreased as APM inclusion was increased in starter and finisher diets. The income over chick and feed cost generated by broilers fed 0.5% APM was higher than those fed 0% APM but progressively declined as APM level in the diet was increased (Table 8).

DISCUSSION

Broilers fed diets with 2.5 and 5.0% APM had lower body weights (BW) and BW gains (*P*<0.05) at starter and finisher stages. Hagan *et al*. (2016) observed that broilers fed diets containing 4.0% and 6.0% APM had similar BW gains, but had significantly lower BWs than those fed diets containing 0% and 2.0% APM and concluded that any slight increase in APM in broiler diets above 2.0% caused reduction of BW gains in broilers. Reduction of BW gains in broilers can be attributed to the decreased feed intake and the inefficient utilization of dietary nutrients caused by either the presence of anti-nutritional factors or high fiber in the diet (Nwocha *et al*., 2014 and Walugembe *et al*., 2014). The fiber content in broiler diets increased with the increasing levels of APM. Loar *et al*.

Table 4. Proximate and mineral contents of the treatment diets containing different levels of Akasya pod meal (%)

Diets	APM level, %				
	0	0.5	1	2.5	5
STARTER					
Dry matter	88.92	89.21	89.18	89.57	89.66
Crude protein	20.90	20.43	20.28	20.97	20.65
Ether extract	4.33	4.19	4.27	4.30	4.70
Crude fiber	2.58	2.75	3.63	4.00	4.92
Nitrogen free extract	54.5	54.63	54.16	53.88	52.89
Ash	6.61	7.21	6.84	6.42	6.50
Calcium	0.99	1.02	0.99	1.00	1.01
Phosphorus, total	0.77	0.74	0.72	0.73	0.72
FINISHER					
Dry matter	89.34	88.93	88.85	88.28	88.99
Crude protein	20.11	20.16	20.00	19.95	20.07
Ether extract	5.37	5.41	5.04	4.91	5.05
Crude fiber	2.97	3.26	4.16	4.81	5.94
Nitrogen free extract	55.16	53.37	52.11	52.69	51.62
Ash	5.73	6.73	7.54	5.92	6.31
Calcium	0.96	0.96	1.02	1.02	1.02
Phosphorus, total	0.88	0.91	1.01	0.99	0.96

Table 5. Growth performance of broilers fed diets with different levels of Akasya pod meal (APM)

Variables	APM level, %					SEM	P- value
	0	0.5	1	2.5	5		
Body weight, g							
7 days	135	135	135	137	133	0.00	0.881
28 days	1228	1193	1267	1157	1157	0.02	0.111
42 days	2120[a]	2090[ab]	2062[abc]	2000[bc]	1948[c]	0.02	0.002
Body weight gain, g							
8-28 days	1095	1057	1128	1022	1020	5.00	0.123
29-42 days	895	900	800	845	795	8.00	0.156
8-42 days	1987[a]	1955[ab]	1928[abc]	1865[bc]	1815[c]	7.00	0.002
Feed consumption, g							
8-28 days	1878	1893	1900	1862	1885	2.00	0.706
29-42 days	2072	2040	2125	2055	2118	90.00	0.983
8-42 days	3950	3930	4025	3917	4002	104.00	0.972
Feed conversion ratio							
8-28 days	1.73	1.80	1.69	1.83	1.85	0.022	0.305
29-42 days	2.35	2.28	2.68	2.43	2.66	0.120	0.189
8-42 days	1.99	2.01	2.09	2.10	2.21	0.025	0.165
Livability, %	95.00	100.00	96.67	98.33	100.00	22.67	0.307

Note: Means within a row with different superscripts are significantly different ($P<0.05$). SEM= Standard error of mean.

Table 6. Carcass characteristics of broilers fed diets with different levels of Akasya pod meal (APM) [ns]

Variables	APM level, %					CV, %
	0	0.5	1	2.5	5	
Dressing percentage, %						
w/ giblets	78.28	78.16	78.31	78.42	80.10	2.35
w/o giblets	75.49	73.54	73.40	73.87	75.45	3.41
Retail cut yield, %						
Breast	44.24	40.50	42.48	41.6	41.56	8.07
Leg	34.21	34.45	34.21	34.12	33.84	5.07
Wing	13.29	14.10	13.86	14.52	13.94	5.67
Rib back	9.62	10.95	9.55	11.42	10.67	17.96
Retail cut measurement, cm						
Breast length	14.46	14.38	14.19	14.17	13.94	3.53
Breast width	11.23	11.08	11.19	11.38	11.26	3.81
Thigh length	7.40	7.52	7.50	7.46	7.26	2.85
Thigh width	8.35	8.30	8.36	8.45	8.57	3.70
Leg length	11.02	11.09	10.96	10.89	11.10	1.89
Leg circumference	15.64	15.47	15.37	15.27	15.47	2.40
Lean:Fat:Bone	71:09:20	71:09:20	71:10:20	73:09:18	72:09:19	8.72

Note: Means within a row with different superscripts are significantly different ($P<0.05$). CV= Coefficient of variation.

(2010) observed that broilers fed high concentration of fibrous ingredients had decreased body weight gain and Walugembe *et al.* (2014) also attributed the lower gains of broiler to high fiber diets.

Feed intake and FCR of broilers in starter and finisher stages were the same across treatments and these findings were the same with the observation of Barcelo *et al.* (2013). However, Hagan *et al*. (2016) observed differences in feed intake and FCR of broilers when APM levels were increased. The FCR of broilers in a well-managed system should be in a range of 1.9 to 2.15 depending on the nutrient density and feeding management of broilers (Kamran *et al*., 2008). Broilers in both temperate and tropical regions are known to have FCR between 1.8 and 2.5 provided that broilers were fed high energy diets which would result to better FCR (Osti *et al*. 2017). Feed conversion ratio is the main factor that determines farm profit as feed accounts for more than 70% of the production costs (Osti *et al*, 2016). The broilers in this study were able to obtain normal FCR values.

The results on cut-up yield, sizes of cuts, lean, fat, bone composition of the whole leg and breast retail cuts were also in agreement with the observations of Barcelo *et al.* (2013) who reported that the carcass yield of broil-

Table 7. Nutrient digestibility in broiler fed with different levels of Akasya pod meal (APM)

Variables	APM level, %					P value
	0	0.5	1	2.5	5	
Coefficient of digestibility, %						
Crude protein	76.34±0.97[a]	74.12±0.85[a]	76.14±4.63[a]	69.57±4.81[ab]	64.81±0.18[b]	0.004
Ether extract	98.43±1.01[a]	90.90±2.72[a]	78.58±15.93[ab]	70.12±5.60[a]b	61.41±7.45[b]	0.010
Crude fiber	67.31±5.19	64.85±9.60	66.75±8.36	62.27±4.95	56.79±6.05	0.408
Nitrogen-free extract	49.50±4.66	54.66±3.58	52.24±2.18	55.90±2.31	56.65±5.38	0.171
Gross energy	86.75±1.17	85.30±1.43	86.35±2.00	83.73±3.89	82.20±3.13	0.235
Digestible nutrient, %						
Crude protein	15.36±1.23	14.70±0.20	15.25±1.57	13.93±2.17	13.00±0.69	0.260
Ether extract	4.26±0.25	3.81±0.25	3.36±0.89	3.04±0.24	2.92±0.52	0.148
Crude fiber	0.52±0.01	0.49±0.10	0.48±0.08	0.46±0.06	0.41±0.12	0.454
Nitrogen-free extract	57.11±5.51	63.84±7.10	62.69±2.62	66.05±4.51	65.81±5.62	0.260
Metabolizable energy, kcal/kg	2548±81.68	2518±38.84	2530±67.43	2471±88.51	2450±74.51	0.462

Means within a row with different superscripts are significantly different ($P<0.05$)

Table 8. Economic analysis of broilers fed diets with different levels of Akasya pod meal (APM) using the feed, chick and broilers farm gate prices at the time of the study

Variables	APM % level				
	0	0.5	1	2.5	5
Average feed consumed, kg	4.22	4.2	4.29	4.18	4.27
0-7 d (booster feed)	0.27	0.27	0.27	0.27	0.27
8-48 d (starter feed)	1.88	1.89	1.9	1.86	1.88
29-42 d (finisher feed)	2.07	2.04	2.12	2.05	2.12
Total feed cost, USD[1]	1.75	1.74	1.77	1.73	1.77
Total feed and chick cost, USD[2]	2.1	2.09	2.12	2.08	2.12
Average live weight, kg	2.12	2.09	2.06	2	1.95
Livability, %	95	100	96.67	98.33	100
Sales from finished broilers, USD[3]	2.84	2.95	2.81	2.78	2.75
Income over feed and chick cost, USD	0.75	0.86	0.69	0.7	0.64

Cost of APM in USD per kg is at 0.10.
Direct material cost of feeds in USD per kg for Booster is at 0.608 USD; Starter at 0.402 USD and Finisher at 0.399 USD.
Cost of chick per head in USD at 0.35.
Cost of kg live weight of broilers in USD at 1.41.

ers was not affected by the APM inclusion in diets. The results showed that the use of APM in broiler diets did not affect the metabolic fate of nutrients on muscle, fat, or bone tissue deposition in broilers.

Digestible coefficients of CP and EE were greater in broilers fed diets with APM inclusion less than 2.5%. APM inclusion in broilers diets greater than 2.5% may result to lower nutrient digestibility specifically CP and EE which was observed in this study. Increasing fiber levels brought about by increasing APM inclusion in the diet has possible effects on nutrient digestibility. Dietary fiber has been considered as an energy diluent and as an anti-nutritional factor in poultry feeds because of its negative effect on feed intake and nutrient digestibility (Rougière & Carré, 2010). Under practical feeding conditions, particle size and solubility of the fiber fraction in the digestive environment can affect bird productivity because of their effects on rate of feed passage in the upper part of the GIT and fermentative ability in the distal part (Saki *et al.*, 2011).

The low body weight of broilers fed diets with APM on day 42 contributed to a decline in generated income. Therefore, for cost-effective feeding of broilers using APM, it is recommended that inclusion of APM should be not exceed the 1.0% inclusion rates for both starter and finisher diets for greater income returns and for better growth performances of broilers.

CONCLUSION

Akasya pod meal (APM) can be used as a feed ingredient in broiler diets. APM inclusion at not more than 1.0% is recommended based on the performance of the broilers during study. Income generated was highest at 0.5% level of APM in the diet. Inclusion levels of APM in broiler are recommended to be at 0.5% to 1.0% in starter and finisher diets for optimum performances of broilers.

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