



Effect of Supplementation of *Yucca schidigera* Extract on Ammonia Gas Emission and Performance of Broiler Chickens

Mahfuj Ullah Patoary^{1*}, Mufazzal Hossain¹, Mofassara Akter¹ and Zahir Uddin Rubel²

¹Department of Animal Nutrition, Genetics & Breeding, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh

²Department of Poultry Science, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh

*Corresponding author's E-mail: mahfujullah.sau@gmail.com, ORCID: 0000-0001-6606-5710

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ABSTRACT

The current study was conducted to investigate the efficacy of *Yucca* extract (YE) on ammonia gas emission from litter, evaluate the production performance, carcass characteristics and economic utility in broiler rearing. A trial of 240 day-old commercial broiler chicks was carried out on littered floor for a period of 28 days. The birds were allocated randomly to 3 treatments and a control group with three replications (20 birds/ replication). Feeding management and rearing condition were same for all the groups, as per standard. YE was mixed with drinking water as treatment as follows: 1ml YE per 16 liters of drinking water (T₁), 1ml YE per 20 liters of drinking water (T₂), 1ml YE per 24 liters of drinking water (T₃) and no YE in drinking water i.e control group (T₀). Ammonia level of *Yucca* treated groups were significantly (P<0.05) lower at the 4th week of rearing period than control group. A significant difference (P<0.05) was noted on body weight, feed consumption, body weight gain and feed conversion ratio value of the birds treated with YE. Carcass percentage and edible portion were significantly (P<0.05) greater in all treatment groups than control group. Profit per bird and Benefit cost ratio were also higher (P<0.05) in treatment groups than control group. Among the treatments, the performance of T₂ group was better than other groups. This study concluded that application of YE (1ml/ 20 liters of drinking water) has an important role to reduce ammonia gas emission from broiler litter and increase the birds performance.

Keywords: ammonia control, broiler chicken, litter management, *Yucca schidigera*

INTRODUCTION

Ammonia in broiler farm is a major concern of this modern poultry industry especially for tropical areas. In the case of poultry, about 50% of nitrogen (N) content of freshly excreted manure is in the form of uric acid and it can be very quickly transformed into ammonia (NH₃) by hydrolysis, mineralization, and volatilization (Oenema et al., 2001). Factors that contribute to the formation of NH₃ include temperature, moisture, pH, and nitrogen content of the litter or manure. High temperatures increase bacterial activity and also ammonia production, with a 1 to 2°C rise having a huge effect on ammonia levels (Visek, 1968). Excess NH₃ in broiler house is frequently claimed for growth retardation, poor feed utilization, increase susceptibility to diseases and increase subsequent mortality. Therefore exploring safe and effective ways that control NH₃ level in broiler house and increase immunity has become a research priority (Su et al., 2016).

Yucca schidigera (Agavaceae), commonly named yucca is documented as a source of sustenance and herbal drug by native Indians due to its health-promoting activity

(Patel, 2012; Su et al., 2016). The main applications of *Yucca* powder and juice are in animal nutrition to reduce fecal odors and ammonia, hydrogen sulfide and some other harmful volatile compounds in domestic animal excreta (Cheeke, 2000; Kelly and Kohler, 2003; Gaber, 2006). The former fractions of *Yucca* Extract (YE) are steroidal saponins and polyphenols (Piacente et al., 2005). The steroidal saponin is the main chemical component of YE, which physically binds ammonia, reducing the level of free ammonia and plays significant role on the improvement of economic traits on broiler chickens (Nazeer et al., 2002). YE has positive effects on the growth rates, feed efficiency, and health in livestock (Colina and Chang, 2001; Duffy et al., 2001; Flaoyen et al., 2002; Kaya et al., 2003; Su et al., 2016; Rezaei et al., 2017).

In present study, the effects of 3 different concentrations of YE on ammonia gas emission, production performance and also carcass characteristics of broiler chickens were investigated with attention to economic utility.

MATERIALS AND METHODS

Ethical approval

The present study was conducted according to ethical rules approved by Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Experimental chicks, treatments and management

A total of 240 day-old broiler chicks of “Cobb-500” strain with 43.2 ± 0.3 g average body weight were used in the current study. They were kept in electric brooders equally by maintaining standard brooding protocol. Among them, 180 chicks were distributed randomly in three treatments of Yucca extract providing with drinking water and remaining 60 chicks were distributed as control. Each treatment was divided into three replicates and in each replicate there were 20 birds. The Yucca treated groups were: 1ml YE per 16 liters of drinking water (T_1), 1ml YE per 20 liters of drinking water (T_2), 1ml YE per 24 liters of drinking water (T_3) and the group without YE supplementation was control (T_0). Throughout the period, the chicks were raised in an open-sided broiler house with rice husk-littered floor. *Ad libitum* feeds and water were provided for rapid growth of broiler chicks up to the end of the four weeks. Nutrient content and feed composition was indicated in table 1. The chicks were vaccinated with commercial Newcastle disease vaccine (NDV) and Infectious bronchitis (IB) vaccine through eye drops at 4 days and 21 days. The Gumboro vaccines were given through drinking water at day- 9 and day-17 of the experiment respectively.

Collection of ammonia test kit and experimental chemical (Yucca extract)

To assess ammonia, commercially available Micro Essential pHyrion™ ammonia meter tester paper was collected. The paper was packaged as a 15 foot roll in a pocket sized plastic dispenser with a polypropylene case and it comes complete with a specially calibrated color chart for matching the ammonia level of the broiler farm. The experimental chemical, *Yucca schidigera* extract (No-Gas™ ACI Animal Health) was purchased and it contains saponin steroids and glycocomponents.

Data collection

Body weight and feed intake were determined weekly. The average of the daily recorded ammonia emission was calculated. Feed conversion ratio (FCR) was calculated as the total feed Intake (FI) divided by weight

gain in each replication. Carcass yield of bird was obtained from live weight subtracting blood, feathers, head, shank and inedible viscera. Mortality rate was maintained on a daily basis. Then total survivability of each treatment was calculated as percentage basis.

Economic analysis

The economic feasibility of *Y. schidigera* supplement for broiler production was estimated on the basis of total expenditure and the return from the sale of live birds (Sahoo et al., 2015). The production cost was calculated by considering the expenses involved in chicks, feed, vaccine and medication, litter materials, disinfectant, electricity, labor and YE. Chicks, disinfectant, vaccine, medicine, litter materials, electricity and labor costs were considered as common costs for both the treated groups and control group. All expenses and income were calculated on the basis of market price (USD) at the time of experimental period. Return was calculated by selling the live birds per kg weight and profit was computed by subtracting the expenditure. Benefit Cost Ratio (BCR) was calculated by total income divided by total cost of production. Profit per bird (PPB) calculated by total income per bird subtracting total expenditure per bird.

Table 1. Ingredients and nutrient composition (as-dry matter) of basal diet

Ingredients	Composition (% , unless otherwise noted)
Maize	45.5
Soybean meal (CP 46%)	17.0
Wheat flour	10.0
Bread flour	5.00
Rice bran	4.45
Crude palm oil	3.50
Corn gluten meal (CP 62%)	3.60
Distiller dried grains (CP 27%)	3.00
Meat bone meal (CP 49%)	2.80
Chicken feather meal (CP 79%)	2.00
Bone meal (CP 22%)	1.50
Lysine	0.55
Methionine	0.37
L-threonine	0.08
Salt	0.15
Premix ¹	0.50
Analysed composition	
Metabolizable energy (kcal/kg)	3,300
Dry matter	89.6
Crude protein	21.9
Crude fat	6.40
Crude fiber	5.62
Ash	6.39

¹Mineral-vitamin premix per kg of diet: Ca 2.250 g, P 0.625 g, Fe 3.570 mg, Cu 0.640 mg, Mn 5.285 mg, Zn 0.003 mg, Co 0.001 mg, Se 0.013 mg, I 0.016 mg, vit A 375 IU, vit D 150 IU and vit E 0.080 mg.

Statistical Analysis

Total data were compiled, tabulated and analyzed in accordance with the objectives of the study. The collected data was subjected to statistical analysis by applying one way ANOVA using Statistical Package for Social Sciences (SPSS- 16.0). Differences between means were tested using Duncan's multiple range test and significance was set at $P < 0.05$.

RESULTS AND DISCUSSION

Ammonia assessment

The rate of NH_3 emissions from broiler litter against the 28-days of rearing period at different concentration levels of yucca extract had shown in table 2. ANOVA analysis revealed that the average NH_3 levels in treated

groups and untreated group were insignificant ($P > 0.05$) in 1st three weeks but it varied statistically ($P < 0.05$) at 4th week of rearing period. The T_1 reduced the rate of NH_3 emission to 1/2 of the untreated level, whereas the T_2 reduced this rate to 2/3rd and T_3 reduced 1/5th of the untreated level. Cabuk et al. (2004) also concluded that the supplementation of *Yucca schidigera* to the diet reduced NH_3 concentration in broiler house. Chepete et al. (2012) reported that when YE was applied to laying-hens, in diets significantly reduced NH_3 emission by 44% and 28% for the first two days of manure storage. However, Corzo et al. (2007) reported that the supplementation of 100 ppm of YSE and *Quillaja saponaria* was added in a corn-soybean control diet of broiler chicken, and NH_3 emission was not altered compared with control.

Table 2. Effects of Yucca extract on ammonia gas emissions of broiler litter

Treatment	First week	Second week	Third week	Fourth week
T_0	8.37±0.98	10.23±1.50	14.97±3.79	25.87 ^a ±0.73
T_1	6.87±0.27	8.33±0.91	9.67±0.84	11.87 ^c ±0.37
T_2	7.10±0.30	8.43±0.58	10.37±1.02	15.13 ^c ±1.57
T_3	7.33±0.21	9.37±1.49	11.53±0.54	20.17 ^b ±1.53

Here, T_0 = (Control), T_1 = (1ml YE per 16L of drinking water), T_2 = (1ml YE per 20L of drinking water), T_3 = (1ml YE per 24L of drinking water); Different superscripts in a column means significant different ($P < 0.05$).

Growth performances

Final Live weight

The relative final live weight (g) of broiler chickens in the different groups T_0 , T_1 , T_2 and T_3 were presented in Table 3 and highest value was found in T_2 (1632.03 g). Average final live of Yucca treated groups were about 100 g more than the control group (1515.60 g) ($P < 0.05$). Results also demonstrated that the body weights varied among the treatment groups ($P < 0.05$). Previous researchers stated that the positive effects of dietary supplementation with Yucca products on the growth rates and body weights in different species (Cabuk et al., 2004; Sonia et al., 2005; Sahoo et al., 2015; Su et al., 2016; Ahmed, 2018).

Feed intake

Total feed intake (FI) of different treatment groups and control group have been cataloged in table 3. Result in total FI demonstrated that treatment groups showed significant ($P < 0.05$) difference than control group. T_2 group consumed more feed (2308.63 g) and T_0 (control) group consumed comparatively lower (2296.27 g), whereas T_1 and T_3 consumed 2306.80 g and 2306.40 g respectively. The result also presented that FI of the 1st two weeks (starter phase) significantly ($P < 0.05$) greater in

Yucca treated groups than control and a reversed trend was recorded at finishing stage (Table 5) that was contradictory to Cabuk et al. (2004) who reported that from 21 to 42 and 42nd day of age, the FC was not significantly different. As Yucca contains saponins that acts biological role as a membrane-permeabilising, immunostimulant and hypocholesterolaemic properties and it has found to have significant affect growth and FI in animals (Das et al., 2012).

Feed conversion ratio

There was significant difference ($P < 0.05$) for FCR among the Yucca treated groups and control group (Table 3). The better FCR value was found in T_2 group (1.45), where control group performed poor (1.56). In 1st two weeks there were insignificant ($P > 0.05$) difference among the treated groups with control also, but at the last two weeks (3rd and 4th) result revealed significant ($P < 0.05$) difference. Lundeen, (2000), Sonia et al., (2005) and Sahoo et al., (2015) reported that the efficiency of feed utilization was significantly better in Yucca group which led to significantly ($P < 0.05$) better FCR than control. The broilers exposed to the low concentration of ammonia showed the highest feed efficiency (Shlomo, 2004; Miles et al., 2004) and the study agree with this result as YE affecting ammonia emission.

Survivability

There is not any significant difference among the groups in term of survivability (Table 3) and the reason might be proper biosecurity management. Some researchers reported that lower survivability percentage was recorded in the control group as compared to the treatment group (Aslan et al., 2005; Sahoo et al., 2015).

Carcass characteristics

Carcass characteristics of the birds had shown in table 4 and the result demonstrated that eviscerated weight percentage, breast meat and thigh yield were significantly higher in Yucca treated group ($P<0.05$) than the control group similar to Sahoo et al. (2015). Thus we also

observed, overall yield of edible meat was significantly ($P<0.05$) higher in Yucca groups than the control group.

Economics

The result of economic analysis revealed that Yucca treated groups had significantly ($P<0.05$) better profit than control group (Table 5). Total expenditure per bird was slightly high in treated groups than control but was statistically insignificant ($P>0.05$). So it can be suggested that application of YE with drinking water may be cost-effective management practice to improve shed environment and in turns performance of broiler chicks.

Table 3. Effects of Yucca extract on production performances of broiler chickens.

Treatment	Final live weight (g/bird)	Average BWG (g/bird)	Total FI (g/bird)	Final FCR	Survivability (%)
T ₀	1515.60 ^c ±2.47	1472.40 ^c ±2.46	2296.27 ^b ±3.73	1.56 ^a ±0.01	98.33±1.66
T ₁	1621.87 ^{ab} ±9.76	1575.33 ^{ab} ±7.48	2306.80 ^a ±1.38	1.46 ^b ±0.07	100.00±0.00
T ₂	1632.03 ^a ±3.40	1588.83 ^a ±3.40	2308.63 ^a ±1.02	1.45 ^c ±0.03	100.00±0.00
T ₃	1607.87 ^b ±5.16	1564.67 ^b ±5.16	2306.40 ^a ±1.15	1.47 ^b ±0.03	100.00±0.00

Here, T₀ = (Control), T₁ = (1ml YE per 16L of drinking water), T₂ = (1ml YE per 20L of drinking water), T₃ = (1ml YE per 24L of drinking water), BWG: body weight gain, FI: feed intake, FCR: feed conversion ratio. Different superscripts in a column means significant different ($P<0.05$).

Table 4. Effects of Yucca extract on carcass characteristics of broiler chickens.

Treatment	*Eviscerated weight (%)	*Giblet (%)	**Breast meat (%)	**Drumstick (%)	*Edible (%)
T ₀	59.83 ^c ±1.08	7.40 ^a ±0.57	33.75 ^c ±0.45	16.80±0.35	67.14 ^c ±0.32
T ₁	65.82 ^b ±0.40	6.50 ^{ab} ±0.26	35.09 ^{bc} ±0.34	17.00±0.25	72.07 ^b ±0.34
T ₂	68.39 ^a ±0.56	5.51 ^b ±0.28	37.14 ^a ±0.58	17.17±0.38	73.64 ^a ±0.33
T ₃	67.05 ^{ab} ±0.70	6.11 ^{ab} ±0.46	35.67 ^b ±0.33	17.13±0.31	72.86 ^{ab} ±0.69

Here, T₀ = (Control), T₁ = (1ml Yucca extract per 16L of drinking water), T₂ = (1ml Yucca extract per 20L of drinking water), T₃ = (1ml Yucca extract per 24L of drinking water), *percentage of body weight, **percentage of eviscerated weight. Different superscripts in a column means significant different ($P<0.05$).

Table 5. Effects of Yucca extract on economic aspects of broiler chicken farming.

Parameter	Treatment			
	T ₀	T ₁	T ₂	T ₃
Feed cost (USD) per bird	1.16±0.29	1.17±0.28	1.18±0.21	1.17±0.42
Cost of Yucca extract (USD) per bird	0	0.021	0.017	0.014
Common expenditure (USD) per bird	0.81	0.82	0.81	0.82
Total Expenditure (USD) per bird	1.98±0.30	2.01±0.43	2.01±0.22	1.99±0.27
Receipt per bird when sold (1.55 USD/ Kg Live weight)	2.35 ^c ±0.32	2.50 ^b ±1.2	2.53 ^a ±0.44	2.51 ^b ±0.67
Profit per bird (USD)	0.39 ^c ±0.60	0.49 ^{ab} ±0.97	0.52 ^a ±0.66	0.48 ^b ±1.07
Benefit cost ratio	1.18 ^b ±0.03	1.24 ^a ±0.06	1.25 ^a ±0.03	1.24 ^a ±0.01

Here, T₀ = (Control), T₁ = (1ml YE per 16L of drinking water), T₂ = (1ml YE per 20L of drinking water), T₃ = (1ml YE per 24L of drinking water). Different superscripts in a column means significant different ($P<0.05$).

CONCLUSION

Analyzing the above research findings, this study suggested that the 1ml of *Yucca schidigera* plant extract with 20L of drinking water may be used to minimize the ammonia gas emission, for better production performance, to improve carcass quality and more economic benefit in broiler rearing. *Yucca schidigera* plant naturally not found in many areas of the world but the extract might be commercially available to other countries. The study therefore recommends for hematological parameters on birds immunity. Hence, it could be safely used in broiler rearing for higher economical return without any adversity.

DECLARATIONS

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Author's contribution

Mahfuj Ullah Patoary and Mufazzal Hossain conducted the research, prepared data and performed statistical analysis. Mofassara Akter and Zahir Uddin Rubel wrote the article. All authors checked and confirmed the final form of article.

Competing interests

The authors declared that they have no competing interests.

Consent to publish

All authors informed their consent prior to inclusion in the study.

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