Journal of Animal Research: v.5 n.2, p. 283-288. June 2015

DOI Number: 10.5958/2277-940X.2015.00048.0

Use of Acidified Litter for Broiler Production in Winter Season

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Received: 13 March, 2015 **Accepted:** 22 April, 2015

ABSTRACT

This experiment was conducted to compare the effect of litter amendments by using acidifier on growth performance, carcass characteristics and welfare of commercial broiler chicks along with its economical implication during winter season (December-January months). A total of 180, day-old (Vencobb) broiler chicks were equally and randomly assigned to two litter abatements with alum and sodium bisulphate (ATL and SBTL) treatment groups along with one Control group of 60 birds each for 6 weeks. All the chicks were reared under identical managemental conditions except the treatments. The result revealed that, average body weight gain was significantly ($p<0.05$) highest in SBTL group (1860g) followed closely by ATL (1813g) than the Control group (1770g) at end of 6th week. The growing chicks significantly gained more body weight with better FCR, PER, EER and higher carcass yield with better immunity in the same order of succession. Findings proved that the pH of the acidified treated litter and the control litter had significant difference which clearly reveals the efficiency of litter treatment products to improve the quality of litter thus in turn enhances the productivity and welfare in broiler production.

Keywords: Broiler chick, Acidifier, Poultry litter, Alum, Sodium bisulphate.

Broiler industry is one of the profitable agro industries responsible for employment to the rural masses particularly small and marginal farmers. The poultry sector has been growing at around 8 to10 per cent annually over the last decade with 2.47 million tonnes of broiler meat. About 66.7% of total output from poultry is coming from broiler meat sector (DAHD, 2012-13). In India for broiler production, deep litter system of housing is very common. The litter used in deep litter housing is the source of volatilized ammonia and its management is a key factor which affects the production and health of birds. Dry litter is important for the health and welfare of birds, as well as for the labour working at poultry farms. Caked litter also increases ammonia level thus negatively affecting broiler's health, welfare, growth performance, and carcass quality which is well documented by numerous researchers (Reece *et al*., 1981; Kristensen and Wathes, 2000; Miles *et al*., 2004). Nowadays different chemical compounds are being used to make the litter dry. Food grade Sodium bisulphate and Alum are used as acidifier which proved their efficiency in making poultry litter dry. Sodium bisulphate eliminates ammonia by converting litter ammonium to ammonium sulphate and acidifies the litter by lowering its pH. Similarly, application of alum [$Al_2(SO4)_3 14H_2O$] is another alternative for poultry litter amendment used to decrease either water-soluble phosphorus or ammonia volatilization individually or both. Alum has been used as a cost-effective means to reduce ammonia volatilization from poultry litter in houses (Moore *et al*., 1995; Gilmour *et al*., 2004). Moore and Burns (2000) also proved that litter treated with alum had beneficial effect on the field application as alum lowers water soluble phosphorous.

MATERIALS AND METHODS

Animals and experimental design

Day old, commercial VENCOB-400 broiler chicks with similar body weight and average group weight procured from Venky's India (Ltd.) were used for this experiment. These broiler chicks of equal sex ratio were randomly divided into two treatments and one control group, each having 60 birds in three replications of 20 numbers. The feeding management and rearing conditions were similar for all the groups as per the standard except the litter amendments. The chicks were protected against New Castle and Infectious Bursal Diseases by routine vaccination. The alum sulphate (at the dose rate of 90g/sq. ft.) treated litter (ATL) and sodium bisulphate (at the dose rate of 25g/sq. ft.) treated litter (SBTL) were tested and compared with Control group without any litter amendment during December, 2012 to January, 2013 in winter season. The chicks were fed starter diet (2893 kcal ME /kg, 22.01% CP) for first 3 weeks, and the broiler finisher diet (2909 kcal ME /kg, 20.21% CP) for the following 3 weeks. Feed and fresh water were made available *ad libitum* all the times. The feeds were analyzed for different content as per AOAC International (2007) methods. Birds were cared for under guidelines comparable to those laid down by the Institutional Animal Ethics Committee.

Growth and feed intake

Live weight and feed intake per pen basis were recorded for the calculation of weight gain and feed conversion ratio (feed/gain), energy efficiency ratio (energy intake/gain in live weight) and protein efficiency ratio (gain in live weight/protein intake) during each week period. Mortality, if any, was also recorded daily.

Litter samples

Litter samples were collected from each pen weekly for the pH by using HANNA pHep, pocket pH tester and on alternate weeks for dry matter and nitrogen content estimation by AOAC International (2007).

Immunity

The immune organs like bursa, spleen and thymus were carefully separated and the weight was recorded and expressed in gms. On 7^{th} and 14^{th} day of experiment four birds from each treatment were randomly selected to evaluate the antibody titre for New Castle Disease Virus (NDV).

Carcass quality

On 42^{nd} day, 4 birds (2 male and 2 female) from each treatment groups were randomly sacrificed for recording carcass yield, cut-up parts using the standard procedures of Ricard and Rouvier (1967).

Histo-pathlogy

Samples of trachea, lungs, liver, and kidney were collected for histopathological evaluation at the time of sacrifice.

Behavior

The ethological data of broiler chicks under different groups was recorded by using handy cam video recorder (SONY 755E) and the responses of the birds in all the treatment groups were examined (Estevez *et al*., 2003).

Economic Analysis

The economic ability of ATL and SBTL for broiler production was evaluated on the basis of total expenditure incurred on the used inputs and the return from the sale of live birds. Being common in all the groups, the general inputs and outputs during the whole study were not considered for economical analysis. Cost of feed was calculated as a sum of the products of the price of different ingredients and their proportionate amount used in the feed. Feeding cost was calculated by the average amount of feed consumed in each treatment on phase basis.

Statistical analysis

Statistical analysis was done by using Software Package for Social Sciences (SPSS) Version 17.0 (2008) and one-way analysis of variance (Snedecor and Cochran 1994) with comparison among means was made by Duncan's multiple range test (Duncan, 1955) with significance level of $P \leq 0.05$.

Table 1. Effect of different treatments on the growth performance of broiler chicks

Parameter	Phase	Treatments (Mean ± S.E)		
		Control	ATL	SBTL
Average Weight Gain (g)	Phase I	587.70 ^{a} ± 3.19	619.03 ^{b} ± 4.71	661.27 ^{c} ± 4.36
	Phase II	1182.36 ± 5.20	1193.97 ± 5.04	1198.84 ± 2.41
	Over all	1770.06^{a} ± 6.09	1813.00^{b} ± 1.95	1860.11^{c} ± 4.65
Average Feed Intake (g)	Phase I	912.87 ± 10.05	946.77 ± 23.43	959.29 ± 22.29
	Phase II	2801.00 ± 41.87	2708.40 ± 2.06	2729.30 ± 15.65
	Over all	3713.80 ± 40.71	3655.10 ± 23.57	3688.60 ± 36.15
FCR	Phase I	1.55^{c} ± 0.01	1.53 ^{b} ± 0.03	1.45^{a} ± 0.04
	Phase II	2.37 ^{b} ± 0.02	2.27 ^{a} ± 0.01	2.28 ^{a} ± 0.01
	Over all	2.10 ^{c} ± 0.01	2.02 ^{b} ± 0.02	1.98^{a} ± 0.02
PER	Phase I	2.91^{a} ± 0.02	2.96 ^{b} ± 0.06	3.12^{b} ± 0.09
	Phase II	2.09 ^{a} ± 0.02	2.18 ^{b} ± 0.01	2.17 ^{b} ± 0.02
	Over all	2.31 ^{a} ± 0.02	2.40 ^{b} ± 0.02	2.44^{b} ± 0.03
EER	Phase I	4.49 ^{c} ± 0.56	4.42 ^{b} ± 0.22	4.20^{ab} ± 1.23
	Phase II	6.89 ± 0.07	6.60 ± 0.02	6.62 ± 0.04
	Over all	6.09 ^{c} ± 0.05	5.86 ^{b} ± 0.03	5.76^{ab} ± 0.07
Survivability (%)	Phase I	98.33 ± 1.67	100 ± 0.00	100 ± 0.00
	Phase II	96.67 ± 1.67	98.33 ± 1.67	98.33 ± 1.67
	Over all	95.00 ± 2.89	98.33 ± 1.67	1.67

Mean value bearing different superscripts in a row differ significantly ($p<0.05$)

Table 2. Litter quality assessment parameters of different treatments

Period	Parameters	Treatments (Mean ± S.E)		
		Control	ATL	SBTL
End of 2nd week	pH	7.3 ^{c} ± 0.15	3.9 ^{b} ± 0.13	1.5 ^{a} ± 0.07
	Moisture, %	18.67 ± 3.19	14.17 ± 0.44	15.50 ± 1.32
	N , %	2.10 ± 0.27	2.22 ± 0.09	2.90 ± 0.52
End of 4th week	pH	6.5 ^{b} ± 0.17	3.2 ^{a} ± 0.15	3.4 ^{a} ± 0.35
	Moisture, %	20.50 ± 2.84	18.83 ± 3.66	16.17 ± 2.92
	N , %	4.94 ± 0.51	4.96 ± 0.35	4.62 ± 0.27
End of 6th week	pH	10.3 ^{c} ± 0.06	9.1 ^{a} ± 0.07	9.5 ^{b} ± 0.03
	Moisture, %	30.33 ± 1.76	28.00 ± 0.87	26.33 ± 1.88
	N , %	5.03 ± 0.30	5.36 ± 0.45	5.56 ± 0.34

Mean value bearing different superscripts in a row differ significantly ($p<0.05$)

Table 3. Immune response of broiler chicks under different treatments

Age	Treatments (Mean ± S.E)		
	Control	ATL	SBTL
	(Anti-body titre ,Log2)		
On 7th Day (Post Vaccination)	1.95 ± 0.09	2.18 ±0.14	2.32 ± 0.14
On 14th Day (Post Vaccination)	2.25^{a} ± 0.19	3.00^{b} ± 0.12	3.08^{b} ± 0.14
Weight of lymphoid organs, g			
Bursa	2.63 ±0.07	3.00 ±0.16	3.03 ±0.13
Spleen	1.84^{a} ±0.05	2.15^{b} ±0.10	2.15^{b} ±0.07
Thymus	4.72±0.15	5.45±0.28	5.29±0.18

Mean value bearing different superscripts in a row differ significantly ($p<0.05$)

Table 4. Effect of different treatments on carcass parameter of broiler chicks

Parameters	Treatments (Mean ± S.E)		
	Control	ATL	SBTL
Eviscerated Weight[1] , %	54.10^{a} ± 0.33	58.00^{b} ± 0.48	59.10^{b} ± 0.61
Giblet[1] ,%	5.53 ± 0.24	5.01 ± 0.14	4.95 ± 0.22
Breast[2] ,%	30.33 ± 0.53	31.21± 0.65	31.87 ± 0.15
Thigh[2] ,%	16.97 ± 0.33	18.35 ± 0.65	18.98 ± 0.63
Drumstick[2] ,%	15.8 ± 0.49	15.5± 0.99	15.6± 0.24
Edible[1] ,%	59.50^{a} ± 0.55	62.90^{b} ± 0.57	64.00^{b} ± 0.71
Inedible[1] ,%	40.50^{b} ± 0.64	37.10^{a} ± 0.65	36.00^{a} ± 0.76

Mean value bearing different superscripts in a row differ significantly ($p<0.05$)
[1]Percentage of body weight
[2] Percentage of eviscerated weigh

RESULTS AND DISCUSSION

Growth and feed intake

The overall average body weight gain at 6th week of experiment was significantly ($p<0.05$) highest in SBTL group (1860g) followed closely by ATL group (1813g), while Control group lagged behind with the average body weight of 1770g. The overall efficiency of utilization of feed was significantly ($p<0.05$) better in SBTL group (1.98) than ATL treated litter group (2.02) and the Control (2.10) (Table 1). Significantly ($p<0.05$) higher protein, energy and less feed consumption by the chicks of both the treatment groups associated with more weight gain resulted in improved FCR, PER and EER values indicating better efficiency of utilization of feed, protein and energy in broiler chicks on amended litter groups of ATL and SBTL than the control group (Table 1). Guo and Song (2009) also demonstrated improved weight gain and feed conversions for broilers raised over the alum as compared to the untreated litter group. Terzich *et al.* (1998) observed similar trend by using sodium bisulphate as litter material in broiler house.

Litter samples

The dry matter content was statistically non-significant ($p>0.05$) among all the groups. At the start of experiment the pH of Litter used in all the treatment groups was 7.9. The pH value was significantly ($p<0.05$) reduced to 1.5 and 3.9, respectively in SBTL and ATL groups at the end of 2nd week. This acidic pH was maintained up to 4th week of rearing due to acidic nature of litter treatment products in the treated groups (Table 2). Similar type findings were reported by Mc Ward and Taylor (2000) by using alum and sodium bisulphate as litter amendment. Alum addition has also been shown to have zero affect on litter moisture (Burgess *et al*., 1998) and ammonia release from litter is related to litter pH and moisture (Elliott and Collins 1982). Ammonia emissions have been positively correlated (Carr *et al.*, 1990) and negatively correlated (Ferguson *et al*., 1998) with litter moisture content. The nitrogen content as direct indicator of the crude protein was statistically non-significant ($p>0.05$) among all the groups. Choi and Moore (2008) also observed the improved nitrogen percentage in litter amendment. Similarly, Burgess *et al.* (1998) reported that regardless of litter source, treatment of litter samples with $Al_2(SO_4)_3$ by the small batch method resulted in significantly higher nitrogen values.

Immunity

The data for antibody titre on 7th day of post vaccination of New Castle Disease in both the litter treated groups

were statistically similar to the Control group. On 14th day of post vaccination anti body titre in SBTL (3.08) and ATL (3.00) groups were significantly ($p<0.05$) higher than the Control group (2.25) indicating poor immune response in the control group (Table 3). The weight of spleen was significantly ($p<0.05$) more in both the litter treated groups (2.15) than that of Control group (1.84). But the weight of Bursa and Thymus were not differing significantly ($p>0.05$) among the groups. Swain *et al.* (2002) revealed that higher lymphoid organ weight indicated a better health status. Cheeke (2006) reported a correlation between improved animal resistances to field infections (non specific immunity) and suggested an immune modulator effect which was not confirmed in the present experiments.

Carcass quality

The SBTL (59.10%) and ALT (58.00%) group chicks had significantly ($p<0.05$) higher eviscerated weight than that of the Control (54.10%) chicks. The yield of breast meat, thigh, giblet and drumstick were statistically not differing among the treatment groups as well as the control group (Table 4). The overall yield of edible meat was significantly ($p<0.05$) higher in SBTL (64.00%) and ATL (62.90%) than the Control group (59.50 %). The litter treated groups also exhibited improved performance with respect to carcass characteristics over Control confirming the findings by Mc Ward and Taylor (2000) who noticed significant improvement in carcass yield and prime cuts in the birds raised over the acidified clay amendment.

Histo-pathlogy

Liver of chicks raised on untreated groups had intensified microscopic lesions like congestion, fatty changes, periportal hepatitis, lymphoid follicle formation. Similarly, in the lungs, the microscopic lesions were thickening of inter alveolar septa, bronco- pneumonia, and focal areas of mononuclear cells infiltration. However there was no significant change in kidney samples among all the groups. Favouring to our study, Terzich *et al.* (1998) also reported significantly betterment of respiratory lesions in sodium bisulphate treated litter chicks than that of untreated groups. The reduction in respiratory tract lesions among broilers raised on litter treated groups was attributed to reduction in atmospheric ammonia level.

Behaviour

Significantly ($p < 0.05$) lower percentage to avoid other birds was observed in ATL group (7.65%) than SBTL groups (9.62%) and Control group (10.05%). However, lower percentage of pecking was observed in SBTL group (1.38%) followed by ATL group (1.65%). The variation in agonistic behaviour of broiler chicks attributed to strong influence of treatments in relieving the birds from stress and adversity compared to Control group birds. Control group spent numerically less time in almost all non agonistic behaviour against both treatment groups. The expression of lying, sitting and standing behaviour in Control group was significantly ($p < 0.05$) higher than both treatment groups. Lower percentage of natural behaviour in the Control chicks might be due to discomfort from litter containing more moisture content.

Economic Analysis

The feed cost for starter and grower phase was Rs.21.65 and Rs.20.28 per kg of feed, respectively. The total benefit per bird was 34.05 % in SBTL and 22.63 % in ATL group by usage of acidifier in litter in comparison to the Control was realized. A profit of 27.74 % in SBTL and 19.81 % in ATL group was gained on live weight basis. Economic analysis revealed that the application of these products could be cost-effective management practice to improve shed environment and in turn performance of broiler chicks. The benefits of litter treatment includes 1) heavier birds, 2) improved feed conversion and 3) lower mortality which proves both the litter amendments to be effective in the development of economic traits which in turn develops better economy of production.

CONCLUSION

Acidifier litter either with alum or sodium bisulphate improved the desirable traits such as weight gain, feed efficiency and carcass characteristics by improving the microclimatic condition and health status of broiler chicks. Hence, it was concluded that it can be safely used in broiler rearing for higher economical return without any adversity.

ACKNOWLEDGMENTS

The authors are thankful to the Guru Angad Dev Veterinary

and Animal Science University, Ludhiana, for providing necessary funds and facilities to carry out this research.

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