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Role of Betaine Supplementation on Growth Performance, Transportation Stress and Shrinkage Loss of Broilers during the Summer Season

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ABSTRACT

Background: Heat stress is a major concern in the poultry industry as it causes heavy economic losses. The current study aimed to evaluate the role of betaine supplementation on growth performance, transportation stress and shrinkage loss of broilers during the summer season.

Methods: An experiment was conducted on broiler chicks (n=234), reared in the deep litter up to the 42ndday on diets with or without betaine. The day-old chicks were randomly distributed into three dietary treatment groups *viz*., Control (Birds fed on a basal diet), T1 (Birds fed on a basal diet, supplemented with Optibetaine @ 1 kg/ton of feed), T2 (Birds fed on a basal diet, supplemented with Betaine HCL @ kg/ton of feed). Each dietary treatment comprised six replicates of thirteen birds each.

Result: It was found thatbirds supplemented with betaine significantly improved in LBW/BWG. Supplementation of optibetaine performed best in comparison with betaine HCL and Control group birds by reducing mortality percentage by 2.56% and 6.41% respectively. NCDV HI titre gives numerically high values in betaine supplemented groups. Cellular immunity at the 42nd day of age improved due to optibetaine supplementation. The rise in corticosterone concentration due to transportation stress was more in control group and less in the betaine supplemented group. There was no significant effect on the serum glucose level.The optibetaine supplementation group shows lower shrinkage loss.

Key words: Betaine, Broilers, Production performance, Summer stress.

INTRODUCTION

Heat stress is the centre of attention in commercial poultry farming. High mortality, reduced feed intake, decrease in body weight gain and poor feed efficiency are common adverse effects of heat stress. High environmental temperature causes osmotic changes in cells and disorder in water balance by changing cell water content through dehydration, which disrupts cellular activity (Tucker and Remus, 2001). Reports showed that birds reduce their feed intake by an increase in environmental temperature (Konca and Kirkpinar, 2008). Therefore, using nutritional supplements in poultry feeding is considered a solution to improve feed consumption by these birds, especially under heat. Betaine is an amino acid (trimethyl-glycine) that refers to three methyl groups which it possesses is a naturally occurring amino acid derivative found in a variety of foodstuffs of plant and animal origin. Dietary supplementation of betaine seems to be important to improve productivity and relief the adverse effects of stress (Wang *et al*., 2004). Betaine has roles: it is an osmolyte that assists in cellular water homeostasis. During heat stress, birds have difficulties in maintaining water and ion balance. As a proven osmolytebetaine has been shown to reduce the negative effect of stress on chicken performance. Also, Betaine could reduce the negative effects of dehydration on performance, increases breast yielded and carcass yielded (Wang *et al*., 2004) and improve the immune response (Remus, 2001).

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However, there are very few reports dealing with the effect of betaine on shrinkage loss and transportation stress. So betaine as a feed supplement needs to be tested on growth performance, immune response, transportation stress and shrinkage loss of broiler chicken during the summer season. Therefore, a study was designed to record the effect of Optibetaine and BetaineHCL on broiler birds.

MATERIALS AND METHODS

The experiment was carried out as per the code of practice approved by the Institute of Animal Ethics Committee at Nagpur Veterinary College, Nagpur, Maharashtra-440006, India. The study was conducted in March-May (Temperature: 34.0-41.5°C, Rh%:73.5-79.5). Straight run broiler chicks

(n = 234) of VENCOBB-430 were procured thereafter, the chicks were randomly distributed into four dietary treatments *viz*., Control (Birds fed on a basal diet), T1 (Birds fed on a basal diet, supplemented Optibetaine @1kg/ton of feed), T2 (Birds fed on a basal diet, supplemented with Betaine HCL @1kg/ton of feed). Each dietary treatment was fed to six replicated groups of thirteen birds each. The birds were reared up to 42nd day of age on prestarter, starter and finisher diets. The ingredient and chemical composition of the control and experimental diet for the pre-starter, starter and finisher phases are presented in Table 1. Data regarding growth performance such as live body weight (LBW), body weight gain (BWG), feed intake (FI), feed conversion ratio (FCR) and mortality was recorded during every phase from 0-42 days of age. For humoral immune response and cell-mediated immunity (CMI), 6 birds from each treatment were used. The humoral immune response is measured as serum haemagglutination (HA) titer against chicken red blood corpuscles on the 14th, 21st, 28th, 35th and 42nd day of age. The was CMI measured as a foot web index in response to phytohemagglutinin-Pv (PHA-P) on the 42nd day of age. Birds were transported for a total of 150 km in 3 hours duration at the speed of 50-60km/hour. The shrinkage loss was calculated. Blood was collected before and after transportation and serum was collected for corticosterone concentration estimation by the ELISA method. The production economics for rearing broiler for the complete experimental period was calculated by considering the cost of all inputs and outputs. All the data collected during the study period was statistically analyzed using SPSS-21 in a complete randomized block design.

RESULTS AND DISCUSSION

Growth performance

The broiler birds supplemented with betaine showed significant improvement in LBW/BWG compared to the basal diet-fed broiler birds. It was observed that approx 445 g LBW was higher in betaine-fed broiler birds (Table 2). During the pre-starter (0-14 d) and starter stage (15-28 d), betaine HCL performed well to achieve the higher BWG in broiler birds but in the finisher stage (28-42 d) optibetaine performed well with 81 g higher body weight gain than betaine HCL. The FCR values were recorded best in optibetaine-fed broiler birds. The birds that received dietary optibetaine recorded the lowest mortality 6.41%, whereas, betaine HCl recorded 8.97% compared to the highest mortality in the control group 12.82%. Thus, supplementation of betaine in broiler birds under heat stress reduces the mortality rate by maintaining osmoregulation. Supplementation of optibetaine performed best in comparison to betaine HCL and Control group birds by reducing mortality percentage by 2.56 % and 6.41 % respectively. In accordance to our research findings, Sagan *et al.* (2021) observed that betaine fortification had improved ($P<0.05$ and 0.01) body weight gain, feed conversion ratio and production efficiency factor in the cumulative finisher heat-stress challenge period (19-40 d). Wen *et al*. (2020)observed the influence of dietary betaine on Ross 308 male broiler chicks fed an MCC-based diet supplemented with 0, 20, 250, 500 and 1,000 mg/kg betaine, they found that betaine increased average daily gain and improved feed conversion ratio of broilers during 0 to 42 day whereas feed intake was not affected. Daudu *et al*. (2020) reported that betaine hydrochloride can be included in the diets of broiler chicks up to 4 g/kg diet to improve growth performance. Nutautaite *et al*. (2020) reported that diets supplemented with betaine can increase FCR at all betaine levels in feed, the higher betaine inclusion in feed, the better FCR.

Immune response

Humoral response of haemagglutination inhibition (HI) titer inferred that supplementation of HI titer value was non significantly different among betaine supplementation and basal diet groups (Table 3). However, the numerical higher values were noted in betaine supplemented broiler birds. Betaine supplementations improved the productive performance and reduce the negative impact of heat stress on viability and immune response by improving cell osmoregulation. Cell-mediated immunity response on 42 days, the PHA-P interceded swelling difference was not significant at 24 hr post-infusion in between any of the

Table 1: The composition of experimental diets (per 1 ton).

Ingredients	Experimental diet		
	Pre-starter (0-14 d)	Starter (15-28 d)	Finisher (29-42 d)
Maize	580 Kg	600 Kg	630 Kg
Soybean meal	380 Kg	345 Kg	310 Kg
Soybean oil	10 Kg	25 Kg	30 Kg
Premix	40 Kg	40 Kg	40 Kg
Optibetaine	Treatment 1-Nil	Treatment 1-Nil	Treatment 1-Nil
	Treatment 2-1Kg	Treatment 2-1Kg	Treatment 2-1Kg
	Treatment 3-Nil	Treatment 3-Nil	Treatment 3-Nil
Betaine HCL	Treatment 1-Nil	Treatment 1-Nil	Treatment 1-Nil
	Treatment 2-Nil	Treatment 2-Nil	Treatment 2-Nil
	Treatment 3-1Kg	Treatment 3-1Kg	Treatment 3-1Kg

treatment groups. In the control (C) group birds lowest CMI response values (0.66) were recorded compare to optibetaine (1.13) and betaine HCl (0.73) supplemented birds. Optibetaine supplemented broiler birds recorded the highest values of CMI response compared to basal diet received birds. In accordance to our research findings, Ghasemi (2020) recorded that betaine (Bet; 0 and 1 g/kg of diet) in broilers under heat stress (HS) conditions has improved humoral immunity in heat-stressed broilers. Chand *et al.* (2017) found that the treatment groups had significantly (P<0.05) higher antibody titer against ND as compared to the control group.

H:L Ratio and serum glucose: Hetrophils

Lymphocyte ratio on the 14th day was significantly (P<0.001) higher in the control group than in optibetaine and the betaine HCl supplemented groups(Table 4). Among the treatment group, H:L Ratio values are significantly higher in the

Table 2: Growth Performance of broiler birds supplemented with betaine.

Groups	Control	T1	T2	SEM	P value
Treatment	Basal diet	Basal diet+Optibetaine	Basal diet+Betaine HCL		
Day old weight	45.40	45.60	46.20	0.28	0.52
		Pre starter phase (0-14 d)			
BWG, g	314.20^{b}	372.60^{a}	403.20^{a}	11.47	P<0.001
CFI, g	428.80^{b}	474.80^{a}	487.80^{a}	7.39	P<0.001
LBW, g	359.60^{b}	418.20^{a}	449.40^{a}	11.53	P<0.001
FCR	1.19	1.14	1.09	0.02	0.056
		Starter phase (15-28 d)			
BWG, g	681.00^{b}	907.60^{a}	960.40^{a}	38.42	P<0.001
CFI, g	1666.00^{b}	1707.00^{ab}	1772.80^{a}	17.36	P<0.05
LBW, g	1040.60^{b}	1325.80^{a}	1409.80^{a}	46.67	P<0.001
FCR	1.60^{b}	1.29^{b}	1.26^{a}	0.05	P<0.001
		Finisher phase (29-42 d)			
BWG, g	528.00	686.80	605.00	57.81	0.568
CFI, g	2896.80^{b}	3256.00^{a}	3317.60^{a}	56.31	P<0.001
LBW, g	1569.00^{b}	2012.80^{a}	2014.80^{a}	75.03	P<0.05
FCR	1.85	1.62	1.65	0.07	0.216

SEM is standard error of difference between mean values. P value is probable significance value.

Table 3: Hemagglutination inhibitor (HI) titer (log2) against NCDV and Cell mediated immune response (CMI) in broiler birds supplemented with betaine.

Groups	Control	T1	T2	SEM	P value
Days	Basal diet	Control+Optibetaine	Control+Betaine HCl		
14	0.500	0.500	0.500	0.121	1
21	2.160	2.257	2.310	0.046	0.423
28	2.310	2.450	2.493	0.039	0.136
35	2.695^{b}	2.962^{a}	3.085^{a}	0.050	P<0.05
42	3.192	3.245	3.245	0.022	0.553
			Cell mediated immune response		
42	0.66	1.13	0.73	0.14	0.35

SEM is standard error of difference between mean values. P value is probable significance value.

Table 4: Heterophil : lymphocyte ratios (H:L Ratios) response in broiler birds supplemented with betaine.

Groups	Control	T1	T2	SEM	P value
Days	Basal diet	Control+Optibetaine	Control+BetaineHCl		
21 d	0.48^{a}	0.41^{b}	0.33^{c}	0.02	P<0.001
28 d	0.43^{a}	0.31^{b}	0.31^{b}	0.01	P<0.001
35 d	0.53^{a}	0.43^{b}	0.42^{b}	0.01	P<0.05
42 d before transport	0.61^{a}	0.50^{b}	0.54^{ab}	0.02	P<0.05
42 d 3 hr after transport	0.87^{a}	0.74^{b}	0.72^{b}	0.02	P<0.05

SEM is standard error of difference between mean values, P value is probable significance value.

optibetaine supplemented group than in the betaine HCl supplemented group. Similar patterns were observed on the 28th and 35th days. On the 42nd days before transportation H:L Ratio was significantly(P<0.001) higher in the control group than in the optibetaine supplemented group. On the 42nd day after transportation H:L Ratio of the control group was significantly (P<0.05) higher in control group than optibetaine and betaineHCl supplemented group. During the

Table 5: Serum glucose level (mg/dl) of broilers supplemented with betaine.

Groups	Control	T1	T2	SEM	P value
Days	Basal diet	Control+Optibetaine	Control+Betaine HCl		
21 d	235.28	233.13	232.17	3.37	0.94
28 d	218.60	200.54	208.92	4.93	0.35
35 d	207.77	199.82	238.05	7.47	0.08
42 d before transport	251.92	234.85	246.67	7.47	0.66
42 d 3 hr after transport	269.12	250.83	259.73	5.38	0.41

SEM is standard error of difference between mean values, P value is probable significance value.

Table 6: Serum corticosterone level (ng/ml) of broiler birds before and after transportation at 42 d age.

Groups	Control	T1	T2	SEM	P value
Treatment	Basal diet	Control+Optibetaine	Control+Betaine HCl		
Before transportation	0.90	0.91	0.80	0.09	0.91
After transportation	1.44	1.23	1.17	0.08	0.35
Difference in corticosterone level	0.54	0.33	0.36	0.10	0.71

SEM is standard error of difference between mean values, P value is probable significance value.

Table 7: Shrinkage loss (g/b) of broiler birds after transportation at 42 d age.

Groups	Control	T1	T2
Treatment	Basal diet	Control+Optibetaine	Control+Betaine HCl
Shrinkage loss (g/per bird)	46.39	37.19	42.56
Shrinkage loss %	2.96	1.85	2.11

Table 8: Production economics of broiler birds supplemented with and without betaine.

Groups	Control	T1	T2
Particulars	Basal diet	Control+Optibetaine	Control+Betaine HCl
Chick cost (`)	30.00	30.00	30.00
Feed cost (`/Kg)	32.00	32.00	32.00
Price of betaine `/kg	0.00	220.00	250.00
Dose of betaine	NA	1kg/T	1kg/T
Cost of optibetaine (`/b)	NA	0.72	0.00
Cost of betaineHCl (`/b)	NA	0.00	0.83
Miscellaneous cost. (`)	3.00	3.00	3.00
Total feed intake (g/b)	2897	3256	3318
Live body weight (g)	1569	2013	2015
FCR	1.85	1.62	1.65
Feed cost (`/bird)	92.70	104.19	106.17
Production cost per bird (`) Chick+Feed+Mis+Betaine	126	138	140
Prod cost per kg	80.30	68.55	69.48
Lifting rate (`/kg/LBW)	80.00	80.00	80.00
Price per bird	125.52	161.04	161.20
Profit per bird (16-13) `	-0.48	23.00	21.20
Shrinkage live body weight loss %	2.96	1.85	2.11
Shrinkage financial loss per 100 kg (`)	237	148	169
Mortality %	12.82	6.41	8.97
Mortality loss per 100 birds (`)	1609	1032	1446

entire period of the experiment serum glucose values were not significantly affected due to supplementation of betaine (Table 5). Moreover, at the end of the trial, there was no significant change in serum glucose level in broiler birds before or after transportation of 3 hr journey. Under our present findings, Scanes *et al.* (2019) reported significant differences in the H:L ratio before and after transportation (P = 0.0027). Ulupi *et al*. (2018) found that transportation causes an increase in the value of the H:L Ratio. In contrast with our present findings. Bedanova *et al*. (2007) found that glucose was increased in both shackled groups of broilers due to stress when compared with the no shackled control group. Nijdam *et al*. (2005) found an increase in glucose value only from before catching to 30 min after the start of catching (210.42±0.9 mg/dl to 218.0±1.27 mg/dl, respectively).

Serum corticosterone concentration and Shrinkage loss

There was no significant effect on corticosterone concentration among the entire treatment group but the values were numerically changed (Table 6). A rise in corticosterone concentration was more in control group and less in the betaine supplemented group. Thus betaine supplementation in the broiler diet may reduce transportation stress. Shrinkage loss was 2.96% in the control group, 1.85% in the optibetaine supplemented group and 2.11% in the betaine HCL supplemented group (Table 7). These indicate that that optibetaine supplementation group shows lower shrinkage loss. Under our research findings, Scanes *et al.* (2019) investigated that plasma concentrations of the corticosterone were low before transportation but were increased (P<0.05) after transportation. Sarkar *et al.* (2013) investigated that Cortisol levels were found to be highly significantly (p<0.01) increased in broilers that were transported by paddle van for a period of 2.5 hours.

Production economics

Considering all inputs (feed, chick, miscellaneous and treatment) and average lifting rate (Indian Broiler Nagpur, Market analysis of 2020) the net profit was calculated (Table 8). The birds that received Optibetaine supplementation produced the highest net profit followed by the flock that received Betaine HCL supplementation.

CONCLUSION

In broiler rearing, Optibetaine @ 1 kg/Ton of feed gave better results than betaine HCL to achieve higher live body weight, better feed conversion ratio and minimum transport stress and shrinkage/weight loss during the summer season.

Conflict of interest: None.

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