



Original Research

Broiler Welfare and Meat Production Efficiency in Tunnel Ventilated Environmental Control *vis-a- vis* Conventional Open Sided Shed Under Different Stocking Densities

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Abstract

Present study was conducted to compare welfare and associated meat production performance and quality of broiler in open sided conventional broiler house (OSCBH) with floor space allowance of 1.0/ft² per chick and in tunnel ventilated environment control broiler house (ECBH) with reducing floor space of 1.0, 0.9, 0.8, 0.7 and 0.6 ft² per chick. Average body lesions score, indicating physical injury and welfare were well within the acceptable limits of European welfare quality protocol. Stress related anti-oxidant enzyme (glutathione peroxidase, lipid peroxidation, superoxide dismutase, catalase and glucose-6-phosphate dehydrogenase) concentrations were higher in OSCBH (T₀) than ECBH (T₁, T₂, T₃, T₄ and T₅). However, percent eviscerated carcass and prime cuts did not decreased significantly ($p \leq 0.05$) in ECBH at higher stocking densities but meat yield per unit floor area was around 90% higher even at 40% reduction of floor allowance.

Key words: Broiler, Meat Yield and Quality, Stocking Density, Tunnel Ventilation, Welfare

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Introduction

Chicken accounts for highest meat production in India. The production of more amount of good quality meat is the ultimate objective of broiler production operations for economy of farmers as well as for whole some hygienic meat supply to consumers. But, being tropical country, heat stress is a major problem in India for fast growing modern commercial broiler strains raised in intensive production system to achieve



above mentioned goal. The effect of heat stress, leading to a series of behavioral, physiological and biochemical adaptive changes (Gupta *et al.*, 2013, Salas *et al.*, 2013, Chib *et al.*, 2015) culminating in serious production and economic losses is fully documented (Al-fataftah and Abu-Dieyeh, 2007 and Quinteiro *et al.*, 2010). Housing environment comprises of stocking density, ambient temperature, relative humidity and ventilation are important factors affecting broiler welfare and meat production performance. Not stocking density but environment management of shed is more important to ensure broiler welfare and carcass quality (Fairchild, 2005). Therefore, raising broiler under controlled temperature and humidity conditions under high stocking density, can not only reduce heat stress but also improves broiler welfare resulting in production of high amount of quality meat.

Keeping in view these problems and prospects, present study was conducted to assess the welfare and meat production efficiency in tunnel ventilated environment control broiler shed at higher stocking densities than BIS recommended floor space allowance of 1 ft²/broiler in conventional open sided shed.

Materials and Methods

This study was conducted on 984 day old sexed commercial Vencobb broiler chicks for a period of 42 days during April-May 2016 at Poultry Research Farm of the Department of Livestock Production Management, GADVASU, Ludhiana.

Broiler Welfare

Broiler chickens welfare under different housings and stocking density was assessed on the basis of rectal temperature, behavioral expression and serum biochemical changes.

Rectal Temperature

Fifteen birds per treatment were randomly picked up to record the rectal temperature twice a week from 3rd week onwards and temperature was measured with the help of clinical thermometer by inserting the latter into the cloaca of the said birds at around 12:00 pm (IST).

Broiler Behavior

The behavioral status of the birds was recorded using Sony® handy cam video recorder for 20 minutes between 12:00-14:00 (IST), twice a week from 3rd week onwards. Instantaneous sampling technique was used for recording the behavior activities like preening, scratching, wing flapping, feeding, drinking, resting and dust bathing of bird in response to various stocking densities and heat stress of broiler chicks on nominal scale.

Body Lesions and Changes

Sixty birds from each treatment in 6th week were randomly selected to record the incidence of body lesions and changes as per European Welfare Quality Assessment Protocol for poultry (Butterworth *et al.*, 2009).

Biochemical Changes

Four birds per treatment were randomly picked to obtain blood samples at 3rd week and 6th week. 3-5 ml of blood was drawn from heart with a sterilized syringe into a sterilized test tube having anticoagulant. Hemolysate was prepared and stored at -20°C for biochemical analysis: Lipid peroxidation (LPO) by Stocks and Dormandy (1971), Glutathione peroxidase (GPx) by Hafeman *et al.* (1974), Superoxide dismutase (SOD) by Marklund and Marklund (1974), catalase (CAT) by Aebi (1983) and Glucose-6-phosphate dehydrogenase (G6PD) by Deutsch (1978) methods.

Carcass Characteristics

Four birds from each treatment were randomly sacrificed at 6th week of age. They were completely bled, scalded at 53°C for 75 seconds and de-feathered by hand picking. The dressed carcass was cut into different cut up parts viz., wings, neck, breast, back, thigh and drumsticks. The weight of inedible parts, i.e. blood, feather and offal was removed. The giblet weight (heart, liver and gizzard) and eviscerated yield were recorded.

Results and Discussion

Broiler Rectal Temperature

The data on rectal temperature of broiler chicks (Table 1) revealed that during different weeks the rectal temperature of birds in OSCBH (T₀) was significantly ($p \leq 0.05$) higher than birds in tunnel ventilated environment control shed under different stocking densities (T₁, T₂, T₃, T₄ and T₅).

Table 1: Average rectal temperature of broiler chicks in different treatments

Shed	Treatment	Weeks			
		3	4	5	6
OSCBH	T ₀	107.03 ^d ±0.09	106.69 ^c ±0.07	107.50 ^d ±0.06	107.71 ^c ±0.04
ECBH	T ₁	105.44 ^a ±0.06	105.82 ^a ±0.09	105.66 ^a ±0.09	106.17 ^a ±0.09
	T ₂	105.81 ^{ab} ±0.09	105.82 ^a ±0.10	106.12 ^b ±0.08	106.23 ^{ab} ±0.07
	T ₃	105.77 ^{ab} ±0.10	106.14 ^{ab} ±0.09	106.09 ^b ±0.11	106.02 ^a ±0.10
	T ₄	106.04 ^{bc} ±0.11	106.44 ^{bc} ±0.08	106.42 ^{bc} ±0.12	106.57 ^b ±0.10
	T ₅	106.20 ^c ±0.12	105.95 ^a ±0.10	106.58 ^c ±0.13	106.60 ^b ±0.13

Means bearing different superscripts for different treatments for different weeks in column differ significantly ($p \leq 0.05$).

However, in ECBH (T₁, T₂, T₃, T₄ and T₅) treatment groups, rectal temperature increased with the increase in age and stocking density. Similar to these results, Cooper and Washburn, 1998 and Altan *et al.*, 2000 also reported significant increase in rectal temperature of birds due to heat stress. But contrary to these findings, Nogueira *et al.*, 2013, found no significant increase in rectal temperature of broiler birds with increasing stocking density. This difference in results can be attributed to variation in climatic conditions, strains and space allowance.

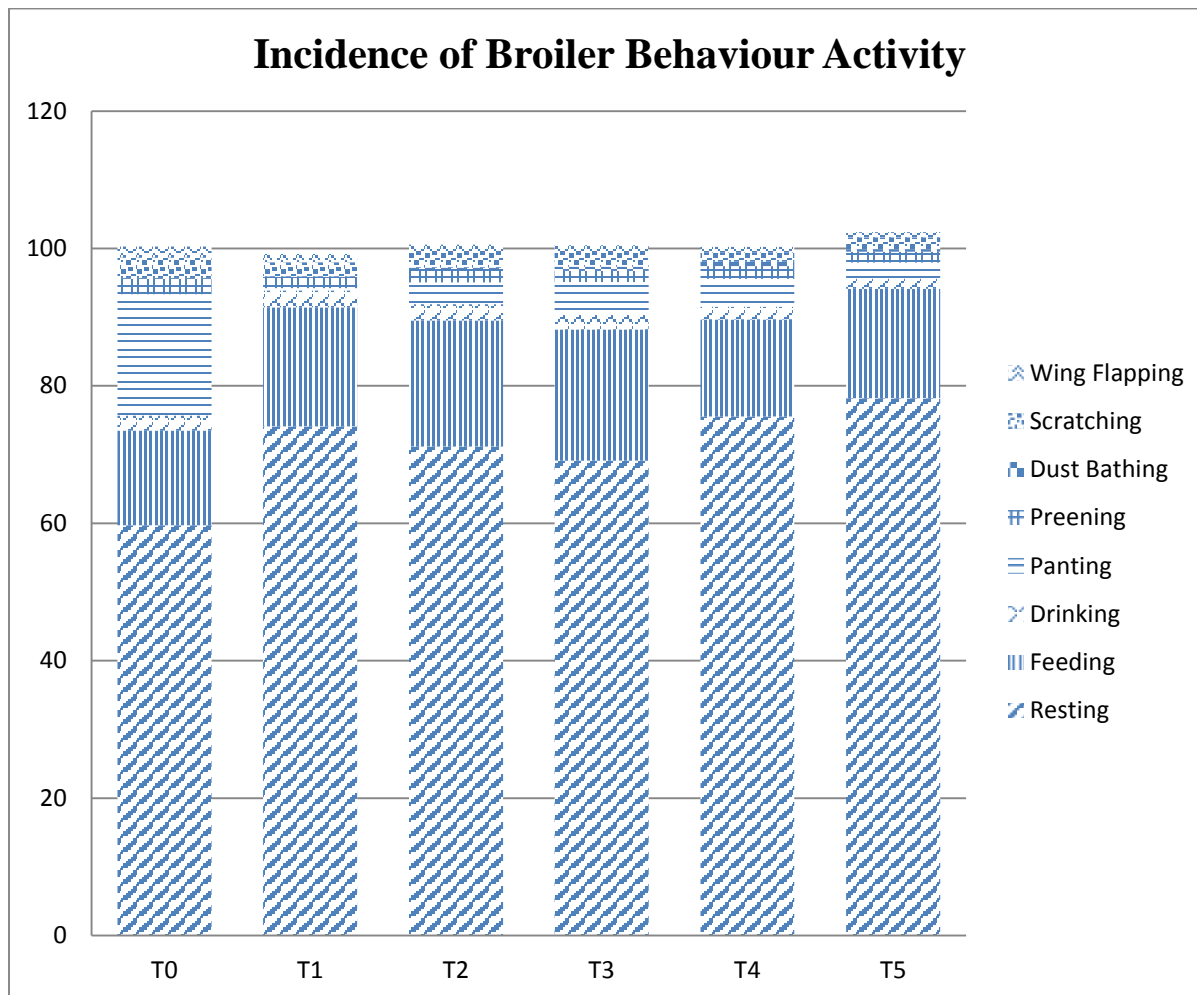
Broiler Behavior

The data on incidence of behaviour activity of broiler birds (Table 2) indicates that the incidence of feeding and resting activity was significantly ($p \leq 0.05$) higher in ECBH (T₁, T₂, T₃, T₄ and T₅) than in OSCBH (T₀). However, panting, preening, dust bathing, wing flapping and scratching activities were significantly ($p \leq 0.05$) higher in OSCBH (T₀) group as compared to ECBH (T₁, T₂, T₃, T₄ and T₅) groups, but, within ECBH treatment groups these activities increased significantly ($p \leq 0.05$) as the stocking density increased. During heat stress birds consume less feed to minimize metabolic heat production and simultaneously scratching, preening and wing flapping increases to increase conductive and convective heat loss while panting to increase evaporative heat loss. So, higher incidence of panting, wing flapping and scratching and simultaneously lower incidence of feeding and resting indicated that broiler birds in OSCBH groups experienced more heat stress than birds in ECBH groups due to better microenvironment conditions (Kaur *et al.*, 2017).

Table 2: Percent incidence of behavioral welfare activities of broilers

Treatment	Resting	Feeding	Drinking	Panting	Preening	Dust Bathing	Scratching	Wing Flapping
T ₀	59.69 ^a ±1.39	13.81 ^a ±0.96	2.18 ^{ab} ±0.29	17.67 ^d ±0.95	2.24±0.47	0.10 ^a ±0.06	3.02 ^b ±0.35	1.56 ^b ±0.21
T ₁	74.10 ^{cd} ±1.16	17.34 ^{ab} ±0.90	2.48 ^b ±0.26	0.31 ^a ±0.15	1.60±0.22	0.12 ^a ±0.06	2.05 ^{ab} ±0.26	1.21 ^{ab} ±0.18
T ₂	71.19 ^{bc} ±1.20	18.35 ^{ab} ±0.89	2.34 ^{ab} ±0.24	3.17 ^{bc} ±0.42	1.97±0.22	0.19 ^a ±0.07	2.15 ^{ab} ±0.22	1.19 ^{ab} ±0.16
T ₃	69.13 ^b ±0.98	19.09 ^b ±0.55	2.09 ^{ab} ±0.20	4.81 ^c ±0.48	1.60±0.30	0.60 ^b ±0.11	2.04 ^a ±0.24	1.12 ^{ab} ±0.13
T ₄	75.57 ^{cd} ±0.95	14.10 ^a ±0.54	1.85 ^{ab} ±0.17	4.04 ^{bc} ±0.44	1.89±0.17	0.66 ^b ±0.11	1.34 ^a ±0.16	0.76 ^a ±0.11
T ₅	78.21 ^d ±0.80	15.93 ^{ab} ±2.20	1.48 ^a ±0.15	2.33 ^{ab} ±0.33	1.58±0.15	0.38 ^{ab} ±0.08	1.73 ^a ±0.17	0.75 ^a ±0.10

Means with different superscripts differ significantly ($P \leq 0.05$)



Body Lesions and Changes

The data on average incidence of foot pad lesion, hock burn, breast blisters, gait score and general cleanliness of broiler birds (Table 3) among different treatment groups ranged from 0.63- 0.97, 0.03-0.12, 0.00 , 0.05-0.18 and 1.02-1.07, respectively.

Table 3: Average score of different body lesions and changes

Shed	Treatments	Foot Pad Lesion	Hock Burn	Breast Blisters	Gait Scoring	General Cleanliness
OSCBH	T ₀	0.63±0.14	0.12±0.04	0.00±0.00	0.12±0.04	1.03±0.03
	T ₁	0.78±0.07	0.07±0.02	0.00±0.00	0.07±0.02	1.02±0.04
ECBH	T ₂	0.73±0.04	0.03±0.02	0.00±0.00	0.08±0.02	1.02±0.04
	T ₃	0.68±0.09	0.03±0.02	0.00±0.00	0.05±0.00	1.02±0.04
	T ₄	0.70±0.03	0.03±0.02	0.00±0.00	0.05±0.00	1.05±0.03
	T ₅	0.97±0.13	0.03±0.02	0.00±0.00	0.18±0.07	1.07±0.04

These results of average score of different body lesions indicating injury and health status of bird as a measure of broiler welfare revealed that birds even at highest stocking density did not experienced any welfare problem. Contrary to these results, Weeks *et al.*, 2000; Dozier *et al.*, 2006 and Skrbic *et al.*, 2009 also reported significant ($p \leq 0.05$) increase of the frequency of poor scores for walking ability (gait score), hock burns and foot pad lesions with increase of stocking density. The difference in the results with the current study might be due to comparatively less space allowance and higher final body weight of birds.

Biochemical Changes

The data on level of stress related anti-oxidant enzyme (Table 4) *viz.* LPO, GPx, SOD, CAT and G6PD concentrations were higher in OSCBH (T₀) than ECBH (T₁, T₂, T₃, T₄ and T₅).

Table 4: Heat stress related biochemical changes in broiler chicks in different treatments

Weeks	Shed	Treatments	Parameters				
			GPx (μ /g Hb)	LPO (nmole MDA/ml)	SOD (μ /g Hb)	Catalase (μ mole H ₂ O ₂ decomposed /min/g Hb)	G6PD (μ mol NADPH/min/g Hb)
3	OCBH	T ₀	0.72 ^a ±0.01 ^A	1.72 ^e ±0.01 ^A	21.85 ^{ab} ±0.73 ^A	6.93 ^e ±0.21	212.05 ^f ±2.15 ^A
		T ₁	0.67 ^a ±0.02	0.94 ^a ±0.01 ^A	21.20 ^a ±0.69 ^A	5.30 ^a ±0.09 ^A	150.19 ^a ±0.39 ^A
	ECBH	T ₂	0.82 ^b ±0.01	1.04 ^b ±0.02	23.75 ^{ab} ±0.22	5.71 ^{ab} ±0.04 ^A	155.93 ^b ±1.05
		T ₃	0.82 ^b ±0.00	1.23 ^c ±0.01 ^A	22.64 ^{ab} ±1.32	6.03 ^{bc} ±0.01	161.49 ^c ±0.59 ^A
		T ₄	0.69 ^a ±0.03 ^A	1.21 ^c ±0.02 ^A	24.45 ^b ±0.33 ^A	6.35 ^{cd} ±0.08	171.90 ^d ±1.12 ^A
		T ₅	0.82 ^b ±0.01	1.63 ^d ±0.01 ^A	22.34 ^{ab} ±0.30 ^A	6.72 ^{de} ±0.06	182.70 ^e ±1.28 ^A
6	OCBH	T ₀	0.88±0.03 ^B	1.79 ^c ±0.02 ^B	28.30 ^c ±0.08 ^B	7.15 ^d ±0.03	230.10 ^f ±0.51 ^B
		T ₁	0.89±0.03	1.03 ^a ±0.01 ^B	25.99 ^a ±0.61 ^B	6.15 ^a ±0.05 ^B	155.48 ^a ±1.11 ^B
	ECBH	T ₂	0.89±0.03	1.05 ^a ±0.01	26.10 ^{ab} ±0.02	6.16 ^a ±0.05 ^B	160.76 ^b ±0.69
		T ₃	0.91±0.02	1.32 ^b ±0.01 ^B	27.29 ^{bc} ±0.08	6.30 ^b ±0.01	172.03 ^c ±0.64 ^B
		T ₄	0.90±0.00	1.31 ^b ±0.01 ^B	27.25 ^{bc} ±0.05 ^B	6.40 ^b ±0.01	186.28 ^d ±0.39 ^B
		T ₅	0.90±0.02	1.80 ^c ±0.02 ^B	28.31 ^c ±0.08 ^B	6.90 ^c ±0.01	196.00 ^e ±0.54 ^B

Means with different superscripts differ significantly ($P \leq 0.05$)

In ECBH group, level of LPO, SOD, catalase and G6PD tends to increase with increase in stocking density and this increase was more evident for G6PD. Over the period from 3rd to 6th weeks of age, level of anti-oxidant enzymes, mainly LPO, SOD, catalase and G6PD also increased for different treatment groups. Earlier, several workers Altan *et al.*, 2003; Mujahid *et al.*, 2005; 2006 and 2007, Lin *et al.*, 2006, 2008 and 2010 reported oxidative injury induced by high ambient temperature leads to production of anti-oxidant enzymes like SOD, CAT, GPx, LPO and G6PD as a first line of anti-oxidant defense (Feng *et al.*, 2008). Therefore, lower rectal temperature, better feed intake and resting behavior and lower incidence of heat dissipating behavior (wing flapping, panting, preening and scratching) and better antioxidant status within

normal acceptable range of body legion score revealed that birds in tunnel ventilated environmental control house (ECBH) had better welfare than birds in open conventional house (OSCBH).

Meat Production

The data on meat production presented in Table 5 indicate that eviscerated carcass weight, prime cut yield (breast, thigh, drumstick, back and neck) of birds in OSCBH (T₀) was numerically lower than birds in T₁, T₂ and T₅ treatments in ECBH. Carcass yield in ECBH groups tends to decrease up to 30% increasing stocking density of birds but again an increase in carcass yield in T₅ (at 40% higher stocking density) in ECBH can be attributed to comparatively lower energy expenditure due to limited mobility and lower decrease in feed intake at higher stocking density. So, in the present study, stocking density did not influence carcass and eviscerated carcass, prime cut and giblet yields in ECBH (T₁, T₂, T₃, T₄ and T₅) groups even at 40% higher stocking density after 6th week of age. These results were in agreement with Nogueira *et al.*, 2013, Fairchild, 2005 and Tong *et al.*, 2012 who reported that carcass and parts yield was not influenced ($p \leq 0.05$) neither by stocking density nor by dietary energy level. Carcass yield per unit space allowance of bird, indicating space use efficiency of chicken meat production, was significantly ($P \leq 0.05$) higher in T₄ and T₅ groups of ECBH than T₀ of OSCBH. Meat production efficiency, in T₄ and T₅ treatment groups in ECBH was 37% and 90% was higher than T₀ group in OSCBH.

Table 5: Effects of different treatments on meat production

Type of Shed	OCBH		ECBH			
Carcass traits (g)	T ₀	T ₁	T ₂	T ₃	T ₄	T ₅
Live Body	1423.75±61.89	1726.00±52.17	1641.00±84.01	1535.00±92.15	1450.00±104.00	1613.75±76.09
Eviscerated carcass weight	885.00±39.55	1063.50±60.15	1005.50±44.78	885.75±59.93	847.75±74.23	1009.25±39.86
Carcass yield per unit area	885.00 ^a ±39.55	1063.50 ^{ab} ±60.15	1117.22 ^{ab} ±49.75	1107.19 ^{ab} ±74.91	1211.07 ^{bc} ±106.05	1682.08 ^d ±66.43

Conclusion

Therefore, it can be recommended that in order to reduce heat stress, broilers can be raised in tunnel ventilated environment controlled sheds at floor space allowance of 0.6 square feet per bird with 90% higher good quality chicken meat production than open sided conventional sheds.

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