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Influence of stocking density on meat quality during short transport

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Abstract
A study was carried out to evaluate the effect of stocking density on meat quality when the birds are transported for a short distance of 150 km. The broiler birds were transported to 150 km with the stocking density 480 and 350 sq cm. There was a significant difference (P<0.05) in the pH, between the broilers transported under different stocking density. There was significant decrease in the pH for the broilers slaughtered with rest for the broilers transported under stocking density of 480 sq.cm. The water holding capacity of the broilers decreased significantly during the transport. There was no significant difference noticed for the broilers transported with feed not withdrawn and slaughtered with rest and without rest. The cooking loss of the broilers decreased significantly during the transport.

Keywords: Broiler birds, meat quality, stocking density

Introduction
Broiler industry is the one of the fastest growing sectors in India. Around 4.2 million metric tonnes of broiler chicken meat is currently produced in India. According to the livestock census the Poultry chicken meat production increased from 0.79 million tons to 4.2 million tons during the year 1980 and 2017. Proportionately the per capita availability also increased from 0.27 kg to 3.6 kg during the same year. The major contributor's states to the output of broiler chicken meat during 2017 are Tamil Nadu, Andhra Pradesh, Maharashtra and Haryana. Due to the intensive system of broiler production the chicken rearing is mostly being carried out in different geographical areas and to be transported by road over a long distance to urban areas or centralized processing plants. The transportation is an essential component of the poultry industry, but places enormous stress on birds because they have little space for behavioural thermoregulation. That leads to weight loss and mortality depending on the temperature. Sowinska *et al.* (2013) [1] and Vecerek *et al.* (2006) [2] reported that the increase in body weight loss was significant with increase in the transport distance. During transport to the slaughterhouse, birds are often exposed to a number of stress factors that can affect meat quality such as improper temperature, adverse microclimate, vibration, motion, impacts, shocks, lack of feed and water, social disruption and noise. The metabolic state of the animal at the time of slaughter determines the initial metabolic state of the muscle postmortem and, as a result, affects the final meat quality (Savenije *et al.* 2002) [3]. The purpose of current study was to determine the effect of stocking density and changes in meat quality in broiler when transported under two different stocking densities for 150 km.

Materials and methods
The selected broilers were feed withdrawn for 4 hours before the transport and without feed withdrawal, the birds were shifted manually and loaded in to the crates (Dimension: 88cm x 52cm). The crates were weighed after filling with the nine broilers per crate with the stocking density 480 sq cm (Indian standard 5238: 2001 Transport of poultry and Code of Practice) in four crates and 13 broilers per crate with the stocking density of 350 sq cm (routine practice) in four crates. The transport trial was conducted during the late evening time starting from seven o clock. The time taken for travelling 150 km was 3 hour. After the transport crates along with the birds were weighed for measuring the weight loss. The birds were slaughtered immediately after transport without rest and by giving rest for 4 hours before slaughter. The broilers were slaughtered and meat samples were collected for the analysis of meat pH, water holding capacity and cooking loss.

Results and discussion

Meat pH

The meat pH (table 1) of the broilers transported for 150 km with stocking density of 480 sq.cm after feed withdrawn and slaughtered without rest and with rest for 4 hour were 5.88±0.04 and 5.82±0.04, respectively and for the broilers transported under stocking density of 350 sq. cm were 5.93±0.06 and 5.94±0.06, respectively. The broilers transported for 150 km with stocking density of 480 sq.cm without feed withdrawal and slaughtered without rest and with rest for 4 hour were 5.74±0.04 and 5.70±0.03, respectively and for the broilers transported under stocking density of 350 sq. cm were 5.93±0.07 and 5.88±0.07, respectively and for the control group the meat pH were 5.74±0.04, respectively. The broilers transported for 150 km with stocking density of 480 sq. cm, with feed withdrawn and not withdrawn, slaughtered after rest had a significant (p<0.05) decrease in the meat pH when compared with the broilers slaughtered without rest. The broilers transported for 150 km with stocking density of 350 sq. cm, with feed not withdrawn, slaughtered after rest had a significant decrease (p<0.05) in the meat pH when compared with the broilers slaughtered without rest.

The results of the current study agreed with the findings of Xing *et al.* (2015) [4] they reported that pH value observed at 24 h is significantly higher for the broilers transported for 4 h. Similarly, Zhang *et al.* (2019) [5] also found that ultimate pH values for the broiler chickens transported for 3 h is higher when compared with control group values. On contrary to the findings Zhang *et al.* (2014) [6] reported that ultimate pH significantly decreased for the birds transported for 3 h, when compared with the broiler transported for 0.75 hr.

Table 1: Mean (± S.E.) pH, WHC and cooking loss in breast muscle of broiler chicken slaughtered without rest and with rest after transport

Rest before slaughter	Feed	Transport distance 150km		
		pH	WHC%	Cooking loss%
Control (without transport)		5.74^{ab}±0.04	73.15^{b}±0.60	34.27^{b}±0.77
Stocking density 480 sq. cm				
Without rest	Withdrawn	5.88^{bc}±0.04	68.21^{ab}±1.10	29.91^{ab}±2.43
4 hour rest		5.82^{abc}±0.04	68.03^{a}±2.55	28.09^{a}±2.13
Without rest	Not withdrawn	5.74^{ab}±0.04	70.05^{ab}±1.67	28.18^{a}±1.74
4 hour rest		5.70^{a}±0.03	69.34^{ab}±0.80	28.97^{ab}±1.25
Overall		5.78±0.02	68.91±0.80	28.79±0.92
Stocking density 350 sq. cm				
Without rest	Withdrawn	5.93^{c}±0.06	67.45^{a}±1.45	29.00^{ab}±2.43
4 hour rest		5.94^{c}±0.06	69.75^{ab}±1.73	31.44^{ab}±1.58
Without rest	Not withdrawn	5.93^{c}±0.07	71.36^{ab}±1.69	29.67^{ab}±1.07
4 hour rest		5.88^{bc}±0.07	71.49^{ab}±1.27	27.05^{a}±2.14
Overall		5.92±0.03	70.01±0.80	29.29±0.94

^{abc}Means with different superscripts in a column differ significantly (P<0.05) (n=6)

Water holding capacity

The WHC (Table 1) of the broilers transported for 150 km with stocking density of 480 sq.cm after feed withdrawn and slaughtered without rest and with rest for 4 hour were 68.21±1.10 and 68.03±2.55, respectively and for the broilers transported under stocking density of 350 sq. cm were 67.45±1.45 and 69.75±1.73, respectively. The broilers transported for 150 km with stocking density of 480 sq.cm without feed withdrawal and slaughtered without rest and with rest for 4 hour were 70.05±1.67 and 69.34±0.80, respectively and for the broilers transported under stocking density of 350 sq. cm were 71.36±1.69 and 71.49±1.27, respectively and for the control group the WHC were 73.15±0.60, respectively. There was significant decrease (p<0.05) in the WHC between the broilers slaughtered without rest and with rest after transport for 150 km. The broilers transported for 150 km under stocking density of 480 sq. cm with feed withdrawn and slaughtered with rest had a significant (p<0.05) decrease in the WHC than the broilers slaughtered without rest. The broilers transported for 150 km under stocking density of 350 sq. cm with feed withdrawn and slaughtered with rest had a significant (p<0.05) increase in the WHC than the broilers slaughtered without rest.

The results of the present study are in agreement with the findings of Delezie *et al.* (2007) [7] observed that water holding capacity for the broilers that were fasted for 10 h, transported for 1.5 h under high stocking density and low stocking density was significantly decreased when compared broilers fasted for 10 h without transport. Tamzil *et al.* (2019b) [8] reported that water holding capacity of broilers transported for 3 h decreased significantly (p<0.01) when compared with the broilers prior to transport. Al-Abdullatif *et al.* (2021) [9] observed that broilers transported for 4 h had lower water holding capacity than the short transported birds. On the contrary to our findings Doktor and Połtowicz (2009) [10] showed that 2.5 h pre-slaughter transport had no significant effect on the water holding capacity of muscles. Prakash and Prabakaran (2020) [11] reported that water holding capacity of breast meat was not influenced significantly ($P \geq 0.05$) by distance of transport involved.

Cooking loss

The cooking loss (Table 1) of the broilers transported for 150 km with stocking density of 480 sq.cm after feed withdrawn and slaughtered without rest and with rest for 4 hour were 29.91±2.43 and 28.09±2.13, respectively and for the broilers transported under stocking density of 350 sq. cm were 29.00±2.43 and 31.44±1.58 respectively. The broilers transported for 150 km with stocking density of 480 sq.cm without feed withdrawal and slaughtered without rest and with rest for 4 hour were 28.18±1.74 and 28.97±1.25, respectively and for the broilers transported under stocking density of 350 sq. cm were 29.67±1.07 and 27.05±2.14, respectively and for the control group the cooking loss were 34.27±0.77, respectively. The broilers transported for 150 km under stocking density of 480 sq. cm with feed withdrawn and slaughtered after rest significantly (P<0.05) reduced the cooking loss when compared with the broilers slaughtered without rest. The broilers transported for 150 km under stocking density of 480 sq. cm with feed not withdrawn and

slaughtered after rest significantly (P<0.05) increased the cooking loss when compared with the broilers slaughtered without rest. The broilers transported for 150 km under stocking density of 350 sq. cm with feed not withdrawn and slaughtered after rest significantly (P<0.05) decreased the cooking loss when compared with the broilers slaughtered without rest.

The results are in agreed with the findings of Tamzil *et al.* (2019) [8] reported that water holding capacity of broilers transported for 3 h decreased significantly (p<0.01) when compared with the broilers prior to transport. Frerichs *et al.* (2021) [12] observed that breast muscle cook loss per cent was greatest for hens under simulated transport of 8 and 12 h than 4 h. However the results are in contrary with the findings of Zhang *et al.* (2019) [5] found that transport duration had no significant effect (P>0.05) on cooking loss, when compared with the control group.

Based on the above study it is concluded that the pH of breast meat increased with the transport distance and with the reduction in the stocking density. The water holding capacity and cooking loss decreased with the transport distance. The broiler chicken can be transported without any significant changes in dressing percentage upto 150 km with feed withdrawal of 4 hour and with rest of 4 hour before slaughter with stocking density of 480 sq cm.

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