THE USE OF ENTHALPY COMFORT INDEX FOR ASSESSMENT OF ON-BOARD THERMAL MICRO-CONDITIONS DURING TRANSPORTATION OF PULLETS

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ABSTRACT

The aim of the present study was to examine the on-board thermal micro-conditions of vehicles using the enthalpy comfort index (ECI) during transportation of pullets during the hot-dry season in Northern Nigeria. Three vehicles were used to transport 2800 Black Harco pullets for 5 hours each during the nighttime. The ECI, which combines an integral part of ambient temperature and relative humidity were recorded at different spots inside the vehicles during transportation. On-board thermal heterogeneity was observed inside the vehicles with significantly higher ($p<0.05$) values of ECI at the centre (120 ± 8.5 KJ/kg) and front (100 ± 5.8 KJ/kg) and lower values recorded at the sides (85 ± 4.5 KJ/kg) and rear (87 ± 7.2 KJ/kg) planes of the vehicles during the transportation period. 80% of the birds that died during the transportation were found in drawers located at the centre with ECI value higher than 100 KJ/kg. In conclusion, transporting pullets under ECI above 100 KJ/kg constituted poor welfare and may result to heat stress and mortality.

INTRODUCTION

Transportation of matured live birds by road is an inevitable component of the poultry industry, and is expanding world-wide due to a significant increase in population and the demand for poultry meat and eggs. In addition, the establishment of new poultry farms and slaughter houses, and the lack of brooding techniques and facilities for slaughter in the newly established farms have increased the need for transportation of matured live birds from one farm to the other or to slaughter and processing houses (Minka and Ayo, 2008, 2012). Known stressors during road transportation include handling and crating, heat stress (Minka and Ayo, (2008, 2012), cold stress (Ritz *et al*., 2005; Knezacek *et al*., 2010; Burlinguette *et al*., 2011), crowding (inability to display thermoregulatory, social stress), vibration, acceleration, noise and deprivation of food water (Mitchell *et al*., 1992; Savenije *et al*., 2002). Among these stressors heat is a major contributor to both death and overall transportation stress in birds (Ritz *et al*., 2005; Knezacek *et al*., 2010; Burlinguette *et al*., 2011; Minka and Ayo, 2012). Heat experience by birds during transportation is exacerbated by climatic factors, inadequate or inappropriate ventilation of the vehicle and high stocking density. When environmental temperature rises above the upper critical temperature, especially at high relative humidity (RH), heat production cannot be reduced effectively in the short term, and hyperthermia could occur (Weeks *et al*., 1997). Thus, to effectively manage poultry transportation, the micro-environmental conditions occurring throughout vehicles must be understood for the full range of ambient temperatures and different ventilation regimes encountered. In tropical Africa, especially in Nigeria, there are no standard vehicles meant for transportation of birds. Livestock including birds are transported in vehicles that are not meant for transportation of animals. Besides, there is a paucity of information on recommended OTC during transportation of poultry in the region. Thus, information is needed to develop recommendations of how to manage OTC during hot or cold weather transportation. Enthalpy comfort index is an index of thermal comfort which expresses the amount of heat in kcal, contained in 1 kg of dry air (Barbosa, 2005). The calculation of enthalpy is directly related to ambient temperature (AT) and RH. These two variables inform the conditions that favour or hinder the heat loss by birds in transported vehicles (Rodrigues *et al*., 2010; Barbosa *et al*., 2014). The objective of the present study was to investigate on-board microclimates temperature during transportation of pullets during the hot-dry season of the year.

MATERIALS AND METHODS

A total of 2800 Shika Brown pullets, aged 15-17 weeks, were transported during the study periods. Transportation of the birds was conducted during the nighttime, between 20:00pm to 1:00am, from Kaduna to Minna, Nigeria during the hot-dry season (between March-April) of the year. Night journeys were preferred than day time due to the adverse effect of heat stress that often occurs during the day time regardless of season of the year. Three commercial articulated Mitsubishi canters, popularly used in the zone for transportation of livestock and goods were used for the experiment. The floors of the vehicles were made of tick wooden planks, while the sides and top roof of the vehicle were not covered, but comprised of interwoven metal iron rods, which formed and held the body of each vehicle tightly. Solid perforated plastic crates, measuring 0.70 m wide, 1.11 m deep and 0.20 m high, were used to contain the birds. The crates were perforated at the floor (1 cm x1 cm) and sides (5 cm x 2.5 cm) for adequate ventilation of the birds. Each crate was loaded with 22 birds and the drawers were then loaded in to the vehicles (Knezacek *et al.*, 2010). Each vehicle carried 900 to 1200 birds. On-board thermal conditions (OTC) which comprise of AT, RH and enthalpy comfort index (ECI) levels were recorded hourly at the front, centre, right and left sides, and rear planes of each vehicle. The AT and RH were recorded with the aid of psychrometers (Brannan, England), fitted at the drawers located at the spots (along the drawer periphery) at bird level (that is in drawers at the front, centre, sides and rear planes). The thermometers were covered with wire-mesh cages to protect sensors from breakage and coming into contact with the birds. The ECI which expresses the amount of heat in 1kg of dry air, in KJ was determined by a formula (Barbosa, 2005; Rodrigues *et al.*, 2010; Barbosa *et al.*, 2014). Data were presented as mean ± standard error of the mean. $P < 0.05$ were considered significant.

RESULTS AND DISCUSSION

Fluctuations in ECI recorded at different spots inside the vehicles during the 5 hours of transportation are shown in Figure 1. Generally, values of the pre-transportation ECI recorded at different spots inside the vehicles immediately after loading and before the start of the journey were significantly ($P < 0.05$) above the corresponding values recorded before loading. As the Journey commenced, the ECI recorded after 30 min to one hour of the journey dropped below the post-load values and the decrease was higher at the rear and sides of the vehicle. On-board thermal heterogeneity was observed inside the vehicles with significantly higher ($P < 0.05$) mean values of ECI in the centre (120 ± 8.5 KJ/kg) and front (100 ± 5.8 KJ/kg) and lower values recorded at the sides (85 ± 4.5 KJ/kg) and rear (87 ± 7.2 KJ/kg) planes of the vehicles during the transportation period. 80% of the birds that died during the transportation were found in the drawers located at the centre with ECI value higher than 100 KJ/kg. The decrease in ECI when the journey commenced was due to adequate airflow which improved ventilation, through the bird's drawers. The higher on-board thermal conditions of ECI at the front and centre, inspite of the effect of wind, suggested that the areas were warmer than the sides and rear planes. This was, apparently, due to reduced air- flow and poor ventilation at the centre of the vehicle. The reduced air-flow, increased in respiratory rate of the birds and heat generated from the birds and from the voided faeces, apparently, increased the moisture content at the centre and front planes. Similar heterogeneous on-board thermal conditions have been reported during transportation of broilers during winter in temperate countries (Hunter *et al.*, 2001; Dadgar *et al.*, 2010; Knezacek *et al.*, 2010; Strawford *et al.*, 2011; Burlinguette *et al.*, 2011). As a comfort index, enthalpy indicates environmental conditions related to heat stress suffered by animals. The high values of ECI recorded at the centre and front planes suggest that the planes were not comfortable for the birds, and they may, thus, suffer heat stress. Although there are no reports on the recommended ECI in transported pullets, studies on broilers showed that ECI of 54-68 KJ/kg of dry air is acceptable during transportation, while ECI values of 69-75.8 KJ/kg and 75.9-90.8 KJ/kg are termed critical and lethal, respectively, and are associated with higher mortality as compared with ECI of 54-68 KJ/kg (Barbosa *et al.*, 2014). The high mortality rate recorded at the centre drawers when the ECI was above 100 KJ/Kg suggested that ECI above 100 KJ/Kg is critical and lethal for pullets. However, the fact that no mortality was recorded at ECI below 100 KJ/kg in the present study, inspite of the suggested critical and lethal ECI values of 70 – 90 KJ/Kg (Barbosa *et al.*, 2014), recorded at the front and sides, and rear planes, suggests that the pullets were able to withstand heat stress better than the broilers. Thus, enthalpy thermal comfort values need to be established for layer birds during transportation in the tropics.

Conclusions

In conclusion, transporting pullets under ECI above 100 KJ/kg constituted poor welfare and may result to heat stress and mortality.

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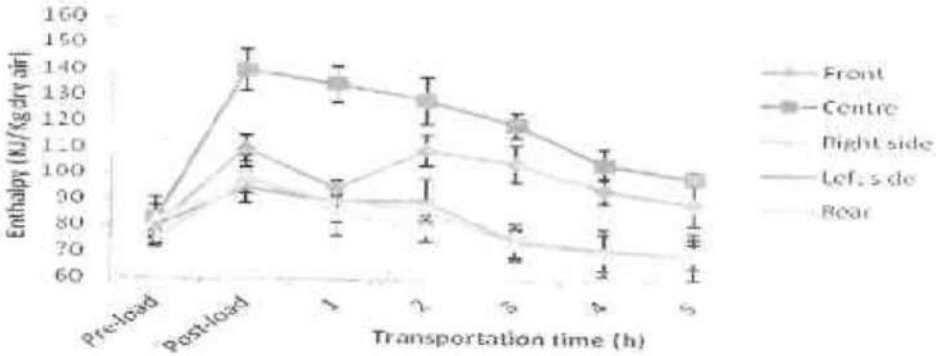

Figure 1: Fluctuations in enthalpy comfort index at different spots inside vehicle during 5 hours of road transportation of pullets