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Effect of stress mitigation measures on the aggressive behaviour and body weight loss of Large White Yorkshire crossbred pigs during transportation#

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Abstract

This study examined the impact of stress mitigation measures on the live body weight loss and skin lesion scores of Large White Yorkshire pigs after a 200 km transportation by road. Twenty-four LWY pigs were randomly allotted into four groups of six each: control group (T_1), pigs injected with vitamin E and selenium (T_2), pigs administered hydrogen-rich water (T_3), and pigs exposed to monochromatic blue light (T_4). Hydrogen-rich water administration (T_3) resulted in the highest live body weight loss, while exposure to monochromatic blue light (T_4) induced the lowest. Shrinkage during transport mirrored the live body weight loss trend. Significant differences emerged in skin lesion scores, notably in the hindquarter and tail regions. Monochromatic blue light exposure (T_4) correlated with reduced aggressive behaviour, evidenced by lower hindquarter skin lesion scores. Conversely, hydrogen-rich water administration (T_3) resulted in higher tail region skin lesion scores. The findings suggest that exposure to monochromatic blue light may have a calming effect during transport and can be recommended as a stress mitigation strategy to enhance overall animal welfare during transportation.

Keywords: *Transportation stress, body weight loss, shrinkage, aggressive behaviou*r

Transportation presents a complex stressor for animals, involving exposure to various stimuli such as social mixing, new environments, temperature and humidity variations, noises and other adverse conditions. These factors can lead to welfare issues and economic losses, including increased skin lesions and body weight loss (Costa *et al*., 2017). Introducing new animals can increase social experiences, potentially resulting in psychological stress and physical fatigue. These pressures are associated with metabolic changes that can lead to poor health, reduced meat quality, economic losses and dehydration. Therefore, animal transportation is highly stressful (Bhatt *et al*., 2021). Factors such as journey duration, road conditions, vehicle type and climatic conditions during the journey can affect pig health and welfare during transportation.

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Extended journeys often result in food deprivation and water for long periods, resulting in weight loss and dehydration, causing a loss of body weight, commonly known as shrink (Schwartzkopf-Genswein and Grandin 2012). The absence of food during transit necessitates animals to rely on body reserves to meet their energy requirements, leading to a decline in blood glucose concentrations. This decline triggers reduced insulin secretion and heightened glucagon secretion from the pancreas, stimulating the liver to increase glycogenolysis and gluconeogenesis to maintain blood glucose concentrations (Knowles *et al*., 2014). Additionally, glucagon promotes the hydrolysis of triglycerides into glycerol and no esterified fatty acids, facilitating their release from adipose tissue for use as metabolic fuel (Deters and Hansen 2022). New groupings result in a new social order, resulting in aggression in which pigs will fight until a relatively stable social hierarchy is formed (Driessen *et al*., 2020). Aggressive encounters often result in skin lesions which exhibited a significant correlation with the frequency of reciprocal fights and the average duration of fighting bouts. Therefore, the aggressive behaviour can be measured using the skin lesion score.

Stress mitigation involves purposeful and systematic measures to reduce or manage stressors, aiming to minimise the negative impact of psychological, physiological or environmental pressures on animals. In the present study, the effect of three stress mitigation measures *viz*. Injection of vitamin E and selenium (Jung *et al*., 2023), administration of hydrogen-rich water produced by electrolysis of water (Aoki *et al*., 2012) and exposure to blue monochromatic light during transport (Mohamed *et al*.,2014) are compared based on the body weight loss, shrinkage and aggressive behaviour of Large White Yorkshire (LWY) crossbred pigs, during and after transporting them 200 km by road from Pookode to Mannuthy in a truck.

Materials and methods

Ethics approval

The study was conducted after obtaining ethical permission from the Institutional Animal Ethical Committee, College of Veterinary and Animal Science, Pookode, Wayanad, Kerala, India. The approval was granted via approval letter IAEC/COVAS/PKD/20/9/2023 dated 20 September 2023.

Study area, experimental and treatments

In this study, twenty-four crossbred LWY pigs, aged between 10-12 months and with uniform body weight were randomly selected from the Instructional Livestock Farm Complex (ILFC) in Pookode located at 11º 32’ 18.5 N, 76 º 01’ 14.15 E and randomly allotted to four distinct groups of six each asT_1, T_2, T_3 and T_4.

All the pigs were transported in a truck, to a distance of 200 km to the Meat Technology Unit, Mannuthy located at 0º 53’ 06 N 76 º 25’ 89 E for slaughter. Among these, six animals were considered as the control group (T_1). Six animals in Treatment-2 (T_2) were injected with vitamin E as Alpha-tocopherol 68 IU/kg and selenium as sodium selenite 10 mcg/kg (Repronol© Cadilla), a total dose of 20 mL deep i/m injections five days before transport. In Treatment-3 (T_3) the six pigs were orally administered hydrogen-rich water that was produced by electrolysis of water by KYK Higen2+ having Solid-Hybrid hydrogen titanium platinum anode and cathode (e-cell), four hours before transport. Hydrogen-rich water had an oxidation-reduction potential (ORP) of -400 mV and an average hydrogen molecule concentration of 1,475 ppb and was obtained by running the machine in H2 mode and adjusting the ORP and pH using a redox meter (Fig. 3.). In

Fig. 1. Oral hydrogen rich water

Fig. 2. Monochromatic blue light

Fig. 3. Skin lesion score -1: superficial scratch

Fig. 4. Skin lesion score - 2: Many (> 3) scratches

treatment-4 (T_4) six pigs were exposed to monochromatic blue light throughout the transportation of wavelength 480 nm and 25 lux intensity using Wipro Next Smart Wi-Fi 20W CCT+RGB LED Batten having 16 million colours, attached to the vehicle (Fig.4.). The decided wavelength could be adjusted through a mobile application and the wavelength of 480 nm was determined using spectrometer and intensity was adjusted by lux meter.

Measurement of body weight

The live body weight of each pig was recorded both at the point of departure before transportation and at the point of arrival after transportation, using a digital platform balance (ALPHA AS1000 1000 Kg Electronic Animal Weighing Scale) of accuracy 100 gm for individual measurements (Fig. 5).

Skin lesion score

The measure of the consequences of aggression, known as the skin lesion score, exhibited a significant correlation with the frequency of reciprocal fights and the average duration of fighting bouts. Hence skin lesion score was assessed to judge the confrontations with other members of the group (Turner *et al*., 2006). The evaluation of the skin lesion score involved a thorough examination of specific body regions, namely the ear, tail and corpus

Fig. 5. Skin lesion score -3: Abrasions

Fig. 6. Skin lesion score – 4: Signs of inflammation

(encompassing the neck/shoulder, rump, back, hindquarter and belly) on the day of transport and after transport, following the criteria established by Baumgartner (2007).

The body of the pig was divided into seven regions - ear, neck/shoulder, rump, back, hindquarter, tail and belly. Each region was inspected and classified into the following categories (Table 1).

Table 1. Score card to assess skin lesion in pig

Lesion Score	Description
0	Without lesion
1	Few scratches (A scratch is defined as a thin, superficial cut on the skin)
2	Many (> 3) scratches
3	Abrasions (An abrasion is a superficial scraping away of skin area of diameter > 5 mm)
4	Signs of inflammation (Characterised by pain, redness, swelling and occasional loss of function)

The highest category of both body sides was recorded.

Statistical analysis

The analysis of the data of shrinkage and live body weight loss was carried out using a one-way analysis of variance (ANOVA) with the SPSS software, version 24.0. Skin lesion scores were subjected to analysis using the non-parametric test Kruskal-Wallis Test. Significant means were tested using -Tukey's test.

Result and discussion

Body weight loss

The result of the live body weight (LBW) loss after the transportation of pigs is presented in Table 2. The highest body weight loss, of 4.50 ± 1.08 kg, occurred in T_3, while the lowest body weight loss of 0.66 kg occurred in T_4. Upon subjecting the means to one-way ANOVA, it was noted that the mean body weight loss during transport was significantly influenced by the treatments (P = 0.011**). Specifically, T_3 exhibited a significantly higher LBW loss compared to T_1 and T_4.

During the transport of pigs to 200 km, the average LBW in the control group (T_1) was only 1.50 ± 0.42 kg, but the highest LBW loss occurred in T_3 where the animals were administered hydrogen-rich water produced by electrolysis (Fig. 1). This might be associated with the stress-mitigating properties of oral hydrogen-rich water, as suggested by Aoki *et al*. (2012). They found that sufficient hydration with hydrogen-rich water before exercise resulted in decreased blood lactate levels and enhanced mitigation of exercise-induced decline in muscle function among athletes. Tamaki *et al*. (2016) reported that hydrogen-rich water could activate the expression of Nrf2, which contributed to endurance during exercise. Due to reduced physical stress from enhanced endurance and less muscle fatigue, animals administered with oral hydrogen-rich water engaged in more activity compared to other treatments, resulting in increased respiration rate and subsequent significant water loss. These heightened activity levels lead to increased energy expenditure compared to other treatments, potentially utilising glucose, glycogen, fatty acids, and protein reserves (Silva *et al*., 2023). This is the reason for higher LBW loss during transport in T_3.

The LBW loss in T_2 in which the pigs were injected with vitamin E and selenium as deep i/m injections five days before transport was 2.33 ± 0.80 kg. It was more than the control group which indicated that injection of Vit E and selenium did not affect the LBW loss of pigs during transportation.

The lowest LBW loss was recorded in T_4 in which the animals were exposed to monochromatic blue light of wavelength 480 nm and 25 lux intensity during the transport (Fig.2). This might be because blue monochromatic light made the animals calmer and less active. Mohamed *et al.* (2014), had made similar observations in broiler chicken. In their study, birds subjected to monochromatic blue light during transportation exhibited reduced weight loss compared to the control group and they attributed this to the fact that the birds were less active and calmer under the influence of monochromatic blue light.

Shrinkage

The shrinkage after transport also followed the same trend as that of live body weight loss during transport. Shrinkage was maximum in T_3 (3.61 ± 0.89 %) and shrinkage was minimum in T_4 (0.53 ± 0.38 %). This was supported by the reports of Deters and Hansen (2022) and Goetz *et al*. (2023). They also stated that the shrinkage exhibited an increasing trend as the distance and water deprivation time were prolonged.

Table 2. Live body weight change and shrinkage in different treatments

Parameters	T_1 (n = 6)	T_2 (n = 6)	T_3 (n = 6)	T_4 (n = 6)	*F*-value	*p*-value
LBW loss (kg)	1.50^{b} ± 0.42	2.33^{ab} ± 0.80	4.50^{a} ± 1.08	0.66^{b} ± 0.49	4.81	0.011**
BW shrinkage (%)	1.11^{ab} ± 0.30	2.22^{ab} ± 0.83	3.61^{a} ± 0.89	0.53^{b} ± 0.38	4.23	0.018**

*** Significant at 0.01 level; * Significant at 0.05 level; ns: non-significant (P>0.05)*

Table 3. Comparison of skin lesion score between different treatments of pigs (Mean rank)

Parameters	T_1 (n = 6)	T_2 (n = 6)	T_3 (n = 6)	T_4 (n = 6)	p-value
Ear (mean rank)	12.33	10.00	11.92	15.75	0.248^{ns}
Neck (mean rank)	11.00	15.00	12.00	12.00	0.670^{ns}
Rump (mean rank)	10.17	10.17	16.67	13.00	0.215^{ns}
Back (mean rank)	10.92	11.33	15.92	11.83	0.533^{ns}
Hind quarter (mean rank)	19.00^{b}	12.50^{ab}	9.25^{ab}	9.25^{a}	0.036*
Tail (mean rank)	9.50^{a}	9.50^{a}	16.92^{b}	14.08^{a}	0.040*
Belly (mean rank)	10.50	10.50	12.50	16.50	0.075^{ns}
Final skin score (mean rank)	14.50	10.67	13.42	11.42	0.759^{ns}

*** Significant at 0.01 level; * Significant at 0.05 level; ns: non-significant (P>0.05)*

The maximum shrinkage, amounting to 3.61 ± 0.89 per cent, occurred in T_3, while the minimum shrinkage of 0.53 ± 0.38 per cent occurred in T_4. Upon subjecting the means to one-way ANOVA, it was observed that shrinkage during transport was significantly influenced by treatments ($p = 0.018$**). Specifically, T_3 experienced significantly higher shrinkage compared to T_4. The shrinkage after transport also followed the same trend as that of live body weight loss during transport (Table 2).

Skin lesion score

The results of the skin lesion scores at the point of arrival, assessed according to Baumgartner's scoring criteria (2007) are presented in Table 3. Analysis using the Kruskal-Wallis Test revealed significant differences among treatments in the scores of the hindquarter and tail regions. Representative skin lesions are depicted in Fig. 3 to 6.

In the hindquarter region, T_1 obtained the highest rank of 19.00, followed by T_2 (12.50), T_3 (9.25), and T_4 (9.25). Notably, T_1 had a significantly higher ($P < 0.05$) skin lesion score than T3 and T_4 in the hindquarter region. In the tail region, the highest mean skin score rank of 16.92 was observed in T_3, followed by T_4 (14.08), T_2 (9.50) and T_1 (9.50). T_3 had a significantly higher ($P < 0.05$) skin lesion score than the other treatments.

T_4 showed a significant ($p < 0.05$) reduction in hind quarter region skin lesion score compared to T_1 as evidenced by Turner *et al*. (2006). They observed that pigs with elevated skin lesion scores tended to take part in more confrontations within the group, suggesting that the T_4 group displayed lower aggression levels than the control. A similar result was observed by Mohamed *et al.* (2014) in broiler birds, stating that birds exposed to monochromatic blue light were less active and calmer compared to birds transported under white light. Driessen *et al*. (2020) stated that skin damages in the middle and hind quarter regions were attributed to mounting behaviour in pigs which occurred in overcrowded pens during the transport procedure.

In the tail region, the highest mean skin score rank was 16.92 in T_3 followed by 14.08 in T_4, and 9.50 each in T_1 and T_2. The highest mean skin score rank of 16.92 in the tail region of T_3 might be because oral hydrogen-rich water reduced the transportation stress which made the pigs more active after loading which led to the drainage of energy after some time, which made them lie down. This exposed the tail regions of the pigs precipitating tail biting due to frustration arising from a lack of environmental resources and physical discomfort as postulated by Henry *et al*. (2021).

Conclusion

Among the three stress mitigation measures compared to ameliorate the transportation stress in LWY crossbred pigs, the exposure to monochromatic blue light had a calming effect, potentially reducing aggressive behaviour in pigs. It also significantly reduced body weight loss and shrinkage after transport. Therefore, exposure to monochromatic blue light of wavelength 480 nm and 25 lux intensity could be recommended to reduce the body weight loss, shrinkage and aggressive behaviour during transport of LWY crossbred pigs and to improve their welfare during transport.

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Conflicts of interest

The authors declare that they have no conflict of interest.

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