Assessing the physiological, behavioural and health impacts of housing upgrades on piglets

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Journal of Livestock Science (ISSN online 2277-6214) 17: 617-622
Received on 10/4/26; Accepted on 11/8/26; Published on 14/8/26
doi. 10.33259/JLivestSci.2026.617-622

Abstract

Present study was conducted on 24 weaned piglets to see the influence of improved housing on micro-environment and piglets' physiology, behaviour and health status. Six piglets in each group were allotted to Solid-concrete floor (T1), Rubber-mat floor (T2), Solid-concrete floor with foggers (T3) and Rubber-mat floor with foggers (T4). Dry-bulb and wet-bulb temperature, piglets' physiological and behavioural parameters, and health status were recorded fortnightly. The mean dry bulb temperature under different housing systems did not differ in morning, but changed significantly ($p<0.05$) during afternoon. The wet bulb temperature as well as temperature humidity index both at morning and afternoon differed statistically ($p<0.05$) among different housing system. Skin temperature and respiration rate of piglets significantly ($p<0.01$) reduced in housing system with foggers. The fogger systems also significantly ($p<0.05$) altered the lying-huddling, belly nosing, ear and tail biting, rooting behaviour and aggressive behaviour. The incidence of enteritis varied among different housing systems ($p<0.05$). Results showed that improved housing system with foggers improved micro-environment and piglets' physiology, behaviour and health along with better growth under different floor systems.

Key words: Foggers; Micro-environment; Physiology; Behaviour; Health

Introduction

In developing countries like India, about 80 percent of the pig population are owned by the weaker section of the society, particularly small or marginal farmers and landless labourers. They mostly rear indigenous breeds of pigs under low or zero input production system for home consumption and/or to supply local market with limited competition (Thomas et al., 2021). The pig has a great potential to contribute to a faster economic return owing to prolificacy and early market age as compared to other domestic farm animals. Additionally, piggery only requires a small initial investment in building and equipment. The piggery sector has a huge potential to ensure nutritional as well as economic security for the weaker sections of the society mainly in developing countries in a sustainable manner. In Asia including India, pig farming is highly unorganized and traditional smallholders, who rear majority share of the pig population and low input demand (Thomas et al., 2021; Wang and Li, 2024). To develop the pig farming as an industry, there is need for transfer of technologies, such as scientific rearing of pigs, marketing strategies, and creation of awareness and importance of pork among the farmers as well as consumers (Bhadouria et al., 2023).

Successful pig-rearing in tropical climates like India requires the provision of suitable improved housing conditions with favourable micro-environment for better performance, health and welfare due to climate change and global warming (Rauw et al., 2020; Thomas et al., 2021). Therefore, pig rearing under the changing climate scenario requires a great deal of management, skill, application of scientific management practices and constant care and attention. However, under field condition practically the above management practices are lacking in most of the livestock farms including piggery (Subhalekha et al., 2022). Among different building structures, floor is in regular contact with animals throughout their life and proper hygiene should be maintained to reduce disease incidences. Previous studies also recorded a significant impact of housing structures particularly flooring system on health and welfare of grower and finisher pigs (Cagienard et al., 2005; Tracey et al., 2018). Improved housing system with environmental enrichment, particularly comfortable micro-environment reduces aggressive behaviour in pigs by developing their social skills and changing behavioral priorities leading to better performance, health and welfare (Nannoni et al., 2016). Hence, the present study was designed to see the influence of improved housing on micro-environment and piglets' physiology, behaviour and health under.

Materials and Methods

The present experiment was conducted at Pig Breeding Unit of Postgraduate Research Institute in Animal Sciences, Kattupakkam, Tamil Nadu, India. The location of the study area was about 40 km South of Chennai city. The latitude and longitude of the study area are 12°49' (North) and 80°2' (East), respectively with an altitude of 36 meters above mean sea level. The climate of the study area was warm-humid and classified as "Tropical maritime monsoon" type. The mean maximum and mean minimum temperature ranged from 28.5°C to 39.1°C and from 21.1°C to 26.5°C, respectively.

Large White Yorkshire piglets (n=24), weaned at 42 days of age (mean body weight about 11.73 kg) were randomly assigned to four types of housing system viz., Control group: Solid-concrete floor (T1), Rubber-mat floor (T2), Solid-concrete floor with water fogging (T3), Rubber-mat floor with water fogging (T4) with 6 piglets (3 males and 3 females) in each housing system. The foggers were operated for 10 minutes automatically once in an hour, between 11.00 am and 3.00 pm to cool the house. The long axis of pig sty was east-west orientation. The roof of the house was asbestos, and a floor space of 1.0 square meter per animal was provided to the piglets. Each pen had feeding trough and nipple drinker, and all the animals were maintained under similar feeding management system. Initially during first fortnight, a concentrate feed of 750 g/animal/day was offered and increased by 250 gm at subsequent fortnight. At the end of the experiment the piglets received a 3 kg concentrate daily per head. The study was conducted from April to August 2023 and the age of the piglets at the start of experiment was 75 days and at the end of experiment was 210 days (i.e., market age). At the time of weaning the piglets were dewormed with Ivermectin suspension (0.2mg/kg body weight). The piglets were vaccinated against Foot and Mouth disease and Swine fever as a standard farm practice. The pens were cleaned and washed daily, and disinfected with 2% Glutaraldehyde solution (Kohrsolin-TH) liquid fortnightly. All biosecurity measures were adopted to provide a safe environment for the animals. The total construction cost of different housing systems including operating cost of foggers during the experimental period were Rs. 6000, Rs. 20,000, Rs. 11530 and Rs. 25530, respectively for T1 (Solid-concrete floor), T2 (Rubber-mat floor), T3 (Solid-concrete floor with water fogging) and T4 (Rubber-mat floor with water fogging).

Wet and dry bulb temperatures were measured fortnightly with a wet and dry bulb thermometer (GM 907 BR) and then temperature humidity index (THI) was calculated using standard formula [THI = 0.72 (dry bulb reading in Celsius + wet bulb reading in Celsius) + 40.6] (McDowell, 1972). Piglets' body surface temperature (°C) and respiration rate (bpm) were recorded twice daily throughout the experiment during moments of animal calmness preceding morning and afternoon feeding sessions as specified by Huynh *et al.* (2007). The respiration rate calculation involved counting flank movements and determining the time required for 10 movements in each identified pig facilitated by the use of a stopwatch following the methodology outlined by Huynh et al. (2007).

The assessment of body surface temperature was conducted at four designated points (ear, shoulder, rib and ham) using an infra-red non-contact thermometer in adherence to the guidelines set by Pang et al. (2011). Piglets were observed for behavioural activities during fogging hours for 10 minutes once in an hour during fogging, period between 11.00 a.m. and 3.00 p.m. Behavioural events such as lying-huddling, belly nosing, wall rubbing, ear biting, tail biting, rooting behavior and aggressive behaviour were recorded. For better interpretation, the percentage of animals in the different behavioral categories was calculated during entire study period (Colson et al., 2012). To evaluate health status, the occurrences of enteritis and skin lesions were recorded during the experimental period. The initial and final body weight of piglets were also recorded to calculate total and daily weight gain.

Statistical analysis

The collected data were statistically analysed by one-way analysis of variance to see effect of foggers on micro-environment and physiological parameters under different housing system. The effect of housing on total and daily weight gain was also estimated using one-way analysis of variance. The pair wise significance ($P<0.05$) between two groups was tested using Duncan's multiple range tests. The different behavioural activities and health related parameters among different groups were analysed by chi-square test. The analyses were carried out using IBM SPSS® Version 20.0 for Windows®.

Results and Discussion

Micro-environment

The morning and afternoon dry-bulb and wet-bulb temperature as well as temperature-humidity index (THI) under different housing systems are presented in table 1. The dry-bulb temperature did not differ during morning among the different housing system, but during afternoon it showed significant variation. The dry-bulb temperature was significantly ($p<0.05$) lower in house with water fogging (T3 and T4) than without water fogging (T1 and T2) at afternoon. Moreover, wet-bulb temperature, at both morning and afternoon was observed significantly ($p<0.05$) lower due to water fogging (T3 and T4) as compared to without water fogging (T1 and T2). The THI, particularly at afternoon reduced significantly ($p<0.05$) due to water fogging (T3 and T4) than without water fogging (T1 and T2).

The results are consistent with the reports of other studies (Correa et al., 2009; Zhou et al., 2015; Rahman et al., 2013), who found that the microclimatic conditions varied significantly depending upon the animal housing and management system. The results are in agreement with Huynh et al. (2004), who reported that water cooling system had positive impact on micro-environment in pig sty. The water-cooling reduced surface temperature of the solid-floor and improved thermal comfort. Hence, under intensive pig production system the fogger system can be recommended for pig rearing in tropical climate under the changing climate scenario. Irrespective of housing system, the afternoon THI remained high. However, the improved housing with water fogging system reduced the micro-environment THI during afternoon, which is in agreement with Huynh et al. (2006).

Tables 1: Micro environmental temperature (dry and wet bulb) and Temperature Humidity Index

Parameters	SCF-Control (T1)	RMF (T2)	SCFF (T3)	RMFF (T4)	'F'- value
Dry bulb temperature (°C)					
Morning (8-9 am)	31.21 ± 0.17	31.20 ± 0.17	30.90 ± 0.15	30.92 ± 0.15	1.21^{NS}
Afternoon (2-3 pm)	$35.39^{a} \pm 0.26$	$35.31^{a} \pm 0.26$	$34.56^{b} \pm 0.25$	$34.58^{b} \pm 0.25$	3.02^{*}
Wet bulb temperature (°C)					
Morning (8-9 am)	$27.39^{a} \pm 0.09$	$27.34^{a} \pm 0.09$	$26.99^{b} \pm 0.09$	$27.05^{b} \pm 0.09$	4.43^{**}
Afternoon (2-3 pm)	$27.82^{a} \pm 0.07$	$27.73^{a} \pm 0.07$	$27.23^{b} \pm 0.07$	$27.33^{b} \pm 0.11$	11.34^{**}
Temperature Humidity Index					
Morning (8-9 am)	$72.79^{a} \pm 0.16$	$72.75^{ab} \pm 0.16$	$72.28^{c} \pm 0.14$	$72.33^{bc} \pm 0.14$	4.07^{*}
Afternoon (2-3 pm)	$76.12^{a} \pm 0.21$	$75.99^{a} \pm 0.21$	$75.09^{b} \pm 0.20$	$75.13^{b} \pm 0.20$	6.98^{**}

SCF- Solid Concrete Floor; RMF-Rubber Mat Floor; SCFF-Solid Concrete Floor with foggers; RMFF-Rubber Mat floor with foggers; Means with different superscripts (a-c) differ significantly ($P<0.05$); * - significant at 5% ($P<0.05$); ** - Significant at 1% ($P<0.01$)

Tables 2: Physiological parameters (skin temperature and respiration rate) of piglets

Parameters	SCF-Control (T1)	RMF (T2)	SCFF (T3)	RMFF (T4)	'F'- value
Skin temperature (°C)					
Morning (8-9 am)	$37.78^{a} \pm 0.04$	$37.69^{a} \pm 0.04$	$37.32^{b} \pm 0.05$	$37.52^{c} \pm 0.05$	17.23**
Afternoon (2-3 pm)	$38.67^{a} \pm 0.05$	$38.24^{b} \pm 0.04$	$37.74^{c} \pm 0.05$	$37.77^{c} \pm 0.05$	74.50**
Respiration rate (breath/ min)					
Morning (8-9 am)	$33.21^{a} \pm 0.16$	$33.06^{a} \pm 0.17$	$32.39^{b} \pm 0.16$	$32.88^{a} \pm 0.15$	4.70**
Afternoon (2-3 pm)	$35.24^{a} \pm 0.16$	$34.31^{b} \pm 0.17$	$31.32^{c} \pm 0.17$	$31.49^{c} \pm 0.16$	138.97**

SCF- Solid Concrete Floor; RMF-Rubber Mat Floor; SCFF-Solid Concrete Floor with foggers; RMFF-Rubber Mat floor with foggers; Means with different superscripts (a-c) differ significantly ($P<0.05$); ** - Significant at 1% ($P<0.01$)

Tables 3: Percentage (%) of behavioural activities and health status of piglets

Parameters	SCF-Control (T1)	RMF (T2)	SCFF (T3)	RMFF (T4)	'$\chi 2$'-value
Behavioural activities (%)					
Lying - huddling	11.29 (7)	29.03 (18)	19.35 (12)	40.32 (25)	11.68^{**}
Belly nosing	9.09 (4)	15.90 (7)	40.90 (18)	34.09 (15)	11.82^{**}
Wall rubbing	21.27 (10)	36.17 (17)	14.89 (7)	27.65 (13)	4.66^{NS}
Ear biting	35.29 (24)	17.64 (12)	32.35 (22)	14.70 (10)	8.71^{*}
Tail biting	46.67 (14)	13.33 (4)	30.00 (9)	10.00 (3)	10.27^{*}
Rooting behaviour	10.25 (4)	48.71 (19)	7.69 (3)	33.34 (13)	17.92**
Aggressive behaviour	41.50 (22)	16.98 (9)	28.30 (15)	13.20 (7)	10.32^{**}
Health status (%)					
Enteritis	17.29 (23)	37.59 (50)	12.78 (17)	32.33 (43)	22.4^{**}
Skin lesions	38.09 (2)	19.04 (7)	3.33 (8)	9.52 (4)	4.33^{NS}

SCF- Solid Concrete Floor; RM F-Rubber Mat Floor; SCFF-Solid Concrete Floor with foggers; RMFF-Rubber Mat floor with foggers; Figures within parenthesis indicate frequency; NS - Not significant (P>0.05); * - significant at 5% (P<0.05); ** - Significant at 1% (P<0.01)

Physiological parameters

The mean skin temperature (°C) and respiration rate (bpm) of Large White Yorkshire weaned pigs maintained under different housing systems at morning and afternoon hours are depicted in table 2. The result revealed that mean skin temperature and respiration rate were higher at afternoon than morning hours and a highly significant difference (p<0.01) between the different groups of weaned pigs maintained under different housing systems.

In a similar line, Huynh et al. (2006) noted that cooling strongly affected skin temperature in the afternoon but had no effect in the morning in grower pigs. The respiration rate was lower in the morning than afternoon with cooling and non-cooling pens. The results are in agreement with Rahman et al. (2013), who noticed that in farm animals, types of housing and floor as well as roof type, breed, season and age of the animal had significant influence on the physiological parameters. Rani et al. (2018) observed that physiological parameters of piglets such as respiration rate and skin temperature recorded in the forenoon and afternoon were significantly (p<0.01) lower in controlled fogging than without fogging. In a similar line,

Behavioural activities

There were high differences in the percentage of all the behavioural activities between the groups during the trial period (table 3), which reflects the impact of the housing systems. The wall-rubbing behaviour did not show any significant difference between the different groups. However, a significant difference (p<0.05) was observed in ear biting behaviour. A highly significant (P<0.01) difference was observed in lying-huddling, belly nosing, tail biting, rooting behaviour and aggressive behaviour among the different groups.

The results are in agreement with Rani et al. (2018), who observed that the comfortable behavioural activities were more displayed in groups maintained under a 5-10 minutes fogging system. The lying and huddling, wall rubbing and rooting behaviour are more in rubber mat floors with or without fogger due to comfortable flooring to dissipate the heat load from the body for the welfare of animals (Huynh et al., 2006). Huynh et al. (2004) demonstrated that cooling a solid pen floor improves the lying behaviour of growing and finishing pigs at high ambient temperatures. It was reported that use of various enrichment or advancement of housing on the reduction of undesirable behaviour such as tail biting, aggression and stereotypes at the pre-weaning, post-weaning and fattening stages of pig production (Godyn et al., 2019).

Health status

The health status (enteritis and skin lesions) of Large White Yorkshire weaned pigs under different housing systems are presented in table 3. Enteritis was observed highest percentage in T2 group, while skin lesions were observed highest percentage in T1 group. Piglets suffered from diarrhoea after weaning due to the sudden change of environment. The frequent diarrhoea observed in groups T2 and T4 housed on a rubber mat floor could indicate a potential issue with the flooring and management practices. The increased biting of the rubber mat in the pigs housed on rubber mat floors suggests a potential issue with the enrichment provided. It could be a sign of frustration, boredom or a need for additional forms of stimulation. Consider diversifying enrichment options such as toys, rooting materials or social interactions to address the observed behavior. Regular observation and adjustments to the enrichment strategy may help improve the well-being of the pigs.

Previous study reported a significant impact of housing systems on the health and welfare of grower and finisher pigs (Cagienard et al., 2005), which is supported by the current study. Tracey et al. (2018) observed that pigs housed in raised floors suffered from lameness and injuries while those in deep litter floors suffered only from diarrhoea or enteritis. The piglets reared on the cement floor had more diarrhoea and no skin diseases compared to the mud floor. They also recommended that slated floor systems experienced fewer health hazards and minimized parasitic infestations as compared to deep litter housing. Sreejith el al. (2022) assessed the skin lesions by tail biting and ear biting and observed a significant difference (p<0.01) among different housing designs. Tracey et al. (2018) did not observe any relationship between roof design, roof material, wall material and health in their locality. However, there was a significant relationship between floor material and health. They advised the farmers to use rough cement floor which are more durable on a gentle slope to allow for easy drainage and cleaning thus minimizing parasitic infestations and also to prevent injuries associated with plank floors.

Body weight gain of piglets

The piglets' body weight gain at the end of experiment were 56.58, 57.41, 60.88 and 58.93 kg, respectively in T1, T2, T3 and T4 groups. The corresponding daily weight gain were 420, 425, 450 and 436 g, respectively. Although, there was no significant (P>0.05) effect of upgraded housing on the weight gain, the average daily gain (450 g/day) was numerically higher in T3 group, i.e., pigs reared in concrete floor with foggers. The result of body weight gain observed in the current study is in agreement with the previous studies (Paiano et al., 2017; Subhalekha et al., 2022). In summer season, a higher body weight gain (40.39kg) and higher average daily gain (480.80 g/day) was observed in weaned pigs reared under-insulated roof with 10 minutes fogging than 5 minutes fogging system (Rani et al., 2018). The concrete floors with foggers' improved housing systems can be recommended for rearing of pigs under tropical region for better productivity as well to provide favourable micro-climate. Further, improved housing system, particularly fogger systems improve feed conversion efficiency of piglets due to comfortable micro-environment (Vasnth et al., 2025).

Conclusions

The improved housing with water fogging system resulted better micro-environment irrespective of the floor type. The pigs reared under improved housing had better body physiology, behaviour and health under different floor systems. Taken together it may be concluded that 'concrete floors with foggers' improved housing systems can be advocated for rearing of pigs under prevailing conditions of tropical climate to provide favourable micro-climate, better health and welfare.

Acknowledgement

The authors express their sincere gratitude for the support and resources offered by Tamil Nadu Veterinary and Animal Sciences University, Chennai, India, which facilitated the successful completion of the research work.

Conflict of interest

There is no conflict of interest among the authors.

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