RESEARCH ARTICLE

Effect of Housing Management Interventions on Microenvironment, Growth, Physiological and Serum Biochemical Parameters of Large White Yorkshire Crossbred Weaner Pigs in Summer

Devireddy Ashok Reddy[1], Suratani Sreedhar[2], Dasineni Suresh Babu[3], Kopparthi Sakunthala Devi[4], Bashyam Nageswara Reddy[1]*

Abstract

The present study was carried out during summer season at the centre of All India Coordinated Research Project on pigs in Tirupati (India) on 24 Large White Yorkshire crossbred weaner pigs of 8 weeks of age and 9-10 kg of body weight, which were randomly divided into four groups (I, II, III and IV) of six animals each (3 males and 3 females). The Group-I was taken as control, Group-II was provided with fan for cooling, Group-III was provided with water splashing over the body, and Group-IV was provided with wet gunny bags around the pen. The study revealed that the housing management interventions had significant effect on all aspects studied. Among the four experimental groups, the Group III (water splashing) had shown the lowest values of temperature-humidity index (78.85±0.13), physiological parameters such as rectal temperature (101.7±0.03 °F), respiration rate (38.17±0.86 breaths/min) and pulse rate (70.36±0.19 beats/min), serum biochemical parameters such as SGOT (55.34±1.38 IU/L) and SGPT (32.67±0.78 IU/L), and the highest values of growth parameters such as final body weight (34.76±0.11 kg) and overall Average Daily Gain (0.28±0.00 kg/day). From the results, it was concluded that splashing water over the animal body proved to be a more effective cooling practice for providing better microenvironment and maintaining better growth performance, as well as normal physiological and biochemical functions in the body, among the housing management practices examined.

Key words: Average daily gain, Large White Yorkshire, Physiological parameters, SGOT, SGPT, Temperature-humidity index.

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Introduction

Swine rearing is a profitable venture because of the special attributes of the species such as highest prolificacy, feed conversion efficiency and dressing percentage, second highest average daily gain (after beef cattle), and shortest generation interval among livestock. Another important feature of the swine species is its ability to convert swill (waste food), tankage (slaughter waste) and agricultural by-products into high quality protein food for humans. Pork is the world's most popular type of meat as it is a rich source of high-quality protein, as well as various vitamins and minerals. Therefore, promoting swine farming in India may help in providing both food and nutrition security to its growing population.

India is a tropical country with hot and humid summer and relatively less stressful winter season. During summer (March to May), the atmospheric temperature goes as high as 45°C during day time and 30°C during night and photoperiod extends up to 12-14 h. The livestock including swine are homeotherms and they show thermo-regulatory responses such as sweating and panting to get rid of heat from the body if the ambient temperature is above the thermoneutral zone. Compared to other species of livestock, swine is more sensitive

[1]Department of Livestock Farm Complex, College of Veterinary Science, Proddatur-516360, SVVU, Andhra Pradesh, India

[2]Department of Livestock Production Management, NTR College of Veterinary Science, Gannavaram-521102, SVVU, Andhra Pradesh, India

[3]Department of Livestock Production Management, College of Veterinary Science, Proddatur-516360, SVVU, Andhra Pradesh, India

[4]Department of Animal Genetics and Breeding, College of Veterinary Science, Proddatur-516360, SVVU, Andhra Pradesh, India

Corresponding Author: Bashyam Nageswara Reddy, Department of Livestock Farm Complex, College of Veterinary Science, Proddatur-516360, SVVU, Andhra Pradesh, India, e-mail: bashyam66@gmail.com

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to high environmental temperatures because it is devoid of functional sweat glands in the skin and has a thick layer of subcutaneous fat which greatly retards the escape of heat. Due to inadequate sweat glands, pig depends on panting as its primary mechanism of heat dissipation (Patience *et al*., 2005). A study conducted by Ross *et al.* (2015) revealed that the pigs' tolerance to heat is on decline due to ongoing selection for litter size and leaner phenotypes. It indicates the urgent need to device the management methods which aid in preventing the heat stress in the species. Previous studies (Myer *et al.,* 2008) pointed towards significant lower weight gains in pigs during summer than those in winter. Therefore, provision of proper microenvironment in the pen is necessary to avoid heat stress and to get optimum production during summer. The present study was aimed at comparing the different housing management interventions with respect to the resulting microenvironment in pens, and growth, physiological and biochemical parameters in pigs.

Materials and Methods

The study was carried out at the centre of All India Coordinated Research Project (AICRP) on pigs located in College of Veterinary Science, Tirupati, functioning under the Sri Venkateswara Veterinary University, Andhra Pradesh (India) for a period of 90 days during summer. A total of 24 Large White Yorkshire crossbred weaner pigs of 8 weeks of age and 9-10 kg of body weight were used for the present study. The animals were randomly divided into four groups (I, II, III and IV) of six animals each (3 males and 3 females). Animals were housed in pens with pakka floors and asbestos roofs. The Group-I was taken as control, Group-II was provided with fan for cooling from 9:00 AM to 5:00 PM daily, Group-III was provided with water splashing over the body at an interval of 2 h between 9:00 AM to 5:00 PM daily and Group-IV was provided with wet gunny bags around the pen.

The animals were fed with grower ration twice a day, which was prepared from maize (60.00%), soya bean meal (24.00%), de-oiled rice bran (14.00%), mineral mixture (1.50%), salt (0.41%) and lysine (0.09%). Before starting the experiment, the sheds were disinfected with potassium permanganate solution. During the experimental period, the pens were cleaned and washed daily before feeding and watering. The feeding and watering troughs were cleaned regularly to avoid infections.

The microenvironmental variables such as dry bulb temperature and relative humidity were recorded thrice a day in each pen. The temperature-humidity index (THI) was calculated by using the following formula from the Livestock and Poultry Heat Stress Indices (1990):

$$THI = db^{o}F - [(0.55\text{-}0.55RH)\ (db^{o}F - 58)]$$

Where, $db^{o}F$ is the dry bulb temperature in Fahrenheit and RH is the relative humidity in decimals (RH %/100).

The animals were weighed at an interval of 15 days during the experimental period before feeding and watering using an electronic weighing balance and the average daily weight gain was calculated.

The physiological parameters, *viz.,* rectal temperature, respiration rate (by flank movement) and pulse rate (in femoral artery) were recorded twice daily at 9:00 AM in the morning and 5:00 PM in the evening.

The blood samples were collected from the ear vein in sterile test tubes at fortnightly intervals, kept undisturbed in slant position for 4-5 h, then centrifuged at 1600 g for 20 min for separation of serum and it was stored at -20°C until analysis. The serum biochemical parameters such as serum glutamic oxaloacetic and pyruvic transaminases (SGOT/AST and SGPT/ALT by Kinetic Assay, Autospan Liquid Gold kits), calcium (End point Assay, Autospan Liquid Gold kits), phosphorus (Molybdate U.V. method, kits from Coral Clinical System), sodium & potassium (electrolyte test kits, Excel Diagnostics Pvt. Ltd), iron (Ferrozine method, kits from Coral Clinical System) and zinc (Colorimetry, kits from Coral Clinical System) were estimated as per the standard procedures using assay kits procured from the manufacturers.

The observations obtained were analysed through statistical tools such as One-way ANOVA using SPSS software version 23.0 as per the procedures laid down by Snedecor and Cochran (1994).

Results and Discussion

Microenvironment in Pens

The temperature-humidity index (THI) is a single value representing the combined effects of air temperature and relative humidity associated with the level of thermal stress. It is a reliable tool for effective management of livestock under different climatic conditions (Davis and Mader, 2002).

The mean values of THI in pens of group I (control), group-II (fan), group-III (water splashing), and group-IV (wet gunny bags) were 82.87±0.19, 80.69±0.14, 78.85±0.13, and 82.13±0.19, respectively. Significant ($p<0.01$) difference was observed in the THI values among all the groups. The lowest mean THI value was observed in group III (78.85±0.13) which is suggesting that the splashing of water is more effective in cooling the microenvironment of shed than other interventions. The findings of the present study are in accordance with those of Sinha *et al.* (2019) and Patel *et al.* (2016).

Growth (Body Weight and Average Daily Gain)

The mean values of body weight (kg) and average daily gain in body weight (kg/day) of Large White Yorkshire crossbred weaner pigs under different housing management interventions are given in Table 1. The highest final body weight (kg) was observed in group III (34.76±0.11) when compared with group I (31.06±0.39), group II (32.49±0.28) and group IV (31.42±0.15). The present findings are in agreement with the observations of Gnanaraj *et al.* (2002). Significant ($p<0.05$) differences were found among body weights of different groups from 15th day of experiment onwards with highest values in Group III.

The overall ADG (kg/day) was significantly ($p<0.05$) higher in group III (0.28±0.00) followed by group II (0.25±0.00). This indicated that provision of water splashing over the body of weaner pigs and arrangement of fans in the pens makes the animals comfortable leading to increased feed intake and higher growth rate. The results of the present study coincided with the findings of Huynh *et al*. (2006).

Physiological Parameters

The physiological parameters such as rectal temperature, respiration rate and pulse rate can be used as important indicators of heat stress and they tend to rise during periods of heat stress. The mean values of physiological parameters of Large White Yorkshire crossbred weaner pigs under different housing management interventions are presented in Table 2.

The mean rectal temperature (°F) differed significantly ($p<0.01$) among different groups. It was lowest in group III followed by group II, group IV and group I (Table 2). The results of the present study suggested that splashing of water over the body was more effective management practice for reducing the heat stress in pigs than others.

The mean respiration rate also differed significantly ($p<0.01$) among different groups with the lowest rate in group III and the highest rate in group I. The lower values of respiration rate in group III, group II and group IV when compared to group I might be due to comfortable cooling effect generated in the pens due to splashing of water over the body in group III, provision of fan in group II and hanging of wet gunny bags around the pen in group IV. These results were in agreement with reports of Huynh *et al*. (2006), Rahangdale *et al*. (2011) and Seerapu *et al*. (2015).

The mean values of pulse rate differed significantly ($p<0.01$) among different groups, being lowest (70.36±0.19 beats/min) in group III, which indicated water splashing as more effective management practice for reducing the heat stress in weaner pigs. Similar findings were observed by Aggarwal and Singh (2008) in buffaloes, and by Omar *et al*. (1996) in lactating HF cows.

Table 1: Mean values of body weight (kg) and average daily gain (kg/day) of Large White Yorkshire crossbred weaner pigs under different housing management interventions

Days of experiment	Group I (Control)	Group-II (Fan)	Group III (Splashing of water)	Group IV (Wet gunny bags)
		Body Weight (kg)		
1st day	9.73 ± 0.18	9.70 ± 0.21	9.76 ± 0.12	9.73 ± 0.12
15th day	11.56^{a} ± 0.13	11.81^{a} ± 0.30	12.22^{b} ± 0.10	11.69^{a} ± 0.14
30th day	13.70^{a} ± 0.12	14.13^{a} ± 0.33	15.37^{b} ± 0.14	13.85^{a} ± 0.25
45th day	16.28^{a} ± 0.17	17.11^{b} ± 0.27	18.69^{c} ± 0.14	16.55^{ab} ± 0.13
60th day	20.47^{a} ± 0.32	21.65^{b} ± 0.25	23.58^{c} ± 0.16	20.81^{ab} ± 0.17
75th day	25.28^{a} ± 0.52	26.48^{b} ± 0.21	28.67^{c} ± 0.15	25.61^{ab} ± 0.20
90th day	31.06^{a} ± 0.39	32.49^{b} ± 0.28	34.76^{c} ± 0.11	31.42^{a} ± 0.15
		Average Daily Gain (kg/day)		
1st -15th day	0.12 ± 0.00	0.14 ± 0.00	0.16 ± 0.00	0.13 ± 0.00
15th-30th day	0.14^{a} ± 0.01	0.15^{a} ± 0.00	0.21^{b} ± 0.00	0.14^{a} ± 0.01
30th-45th day	0.17^{a} ± 0.01	0.20^{b} ± 0.01	0.22^{b} ± 0.00	0.18^{a} ± 0.01
45-60th day	0.28^{a} ± 0.01	0.30^{b} ± 0.01	0.33^{c} ± 0.01	0.28^{a} ± 0.01
61-75th day	0.32^{a} ± 0.02	0.32^{a} ± 0.00	0.34^{b} ± 0.01	0.32^{a} ± 0.01
75-90th day	0.38 ± 0.01	0.40 ± 0.01	0.41 ± 0.01	0.39 ± 0.01
Overall	**0.24^{a} ± 0.00**	**0.25^{b} ± 0.00**	**0.28^{c} ± 0.00**	**0.24^{a} ± 0.00**

The means bearing different superscripts within a row differ significantly ($p<0.05$).

Table 2: Mean values of physiological parameters of Large White Yorkshire weaner pigs under different housing management interventions

Physiological parameter	Group I (Control)	Group-II (Fan)	Group III (Splashing of water)	Group IV (Wet gunny bags)
Rectal temperature (°F)	102.8^{d} ± 0.03	102.3^{b} ± 0.02	101.7^{a} ± 0.03	102.5^{c} ± 0.02
Respiration rate (breaths/min)	49.44^{c} ± 0.35	44.10^{b} ± 0.61	38.17^{a} ± 0.86	46.87^{c} ± 0.69
Pulse rate (beats/ min)	82.30^{c} ± 0.61	77.54^{b} ± 0.61	70.36^{a} ± 0.19	81.04^{c} ± 0.28

The means bearing different superscripts within a row differ significantly ($p<0.01$).

Biochemical Parameters

The mean values of serum biochemical parameters of Large White Yorkshire crossbred weaner pigs under different housing management interventions are presented in Table 3.

The serum glutamic oxaloacetic and pyruvic transaminases are the liver enzymes, concentrations of which tend to elevate during heat stress (Mayengbam and Tolenkhomba, 2015; Siddiqui *et al.*, 2020). They play a key role in gluconeogenesis hence essential for heat stress adaptations (Kaneco *et al.*, 2008). It was the probable reason for higher levels of the enzymes during thermal stress. Both SGOT and SGPT levels differed significantly ($p<0.05$) among the groups with the lowest values in Group III and the highest in control Group I (Table 3), indicating that the management interventions particularly the splashing of water over the body of pigs to cool the microenvironment helps in reducing the heat stress. The present findings were in accordance with Ajuogu *et al.* (2010).

Maintenance of mineral balance in animals is of profound importance as minerals play a key role in bone formation, blood clotting, proper functioning of nerve tissue, regulation of osmotic pressure in body fluids, maintenance of homeostasis in the acid-base balance and acting as co-factors of enzymes or as catalysts in enzymatic reactions. The calcium and phosphorus are the major structural minerals present in animal body. However, no significant difference was observed in serum calcium and phosphorus levels among all the experimental groups of pigs under the present study (Table 3).

The sodium is the chief cation of the extra-cellular fluid while the potassium is the chief cation of the intra-cellular fluid. The levels of sodium and potassium differed significantly ($p<0.05$) among groups of pigs with the highest levels of both the elements in group III. The normal range of serum sodium and potassium is 140-150 and 4.7-7.1 mmol/L, respectively (Radostits *et al*., 2006). The levels of both the elements were slightly increased in all groups of weaner pigs from normal levels which might be due to thermal stress, but the cooling management practices was found helpful in maintaining normal range of potassium levels in the body.

The iron is an important trace mineral required for the formation of haemoglobin. No significant difference was observed in serum iron levels among the experimental groups. Contrary to the present findings, Zeng *et al.* (2023) reported significantly lower haemoglobin concentrations in heat stressed cows, and Attia (2016) observed significantly higher haemoglobin concentrations in heat stressed goats.

The zinc is another essential trace element essential for growth and development, immune competency, appetite, taste, structure and function of more than 200 enzymes associated with carbohydrate and energy metabolism, protein degradation and synthesis, nucleic acid synthesis, carbon dioxide transport, and many other reactions (Pond *et al.*, 1995). There was no significant difference in serum zinc levels among the experimental groups under study (Table 3). The present findings were contrary to those reported by Wang *et al.* (2013) and Borah *et al.* (2014), who observed a decrease in serum zinc concentration due to heat exposure in pigs. Bartlett and Smith (2003) also observed the same in heat stressed broilers. Chaudhary *et al.* (2015) however observed an increase in zinc values with increase in THI in buffaloes. The disagreement was probably due to species differences.

Conclusion

From the results of the present study, it can be concluded that the splashing water over the animal body proved to be a more effective cooling practice for providing better microenvironment and maintaining better growth performance, as well as normal physiological and biochemical functions in the body, among the housing management practices studied.

Table 3: Mean values of serum biochemical parameters of Large White Yorkshire crossbred weaner pigs under different housing management interventions

Serum biochemical parameter	Group I (Control)	Group-II (Fan)	Group III (Splashing of water)	Group IV (Wet gunny bags)
SGOT (IU/L)	$80.85^{c} \pm 1.42$	$67.53^{b} \pm 1.02$	$55.34^{a} \pm 1.38$	$78.37^{c} \pm 0.99$
SGPT (IU/L)	$40.43^{c} \pm 1.55$	$36.12^{b} \pm 0.56$	$32.67^{a} \pm 0.78$	$39.66^{c} \pm 0.87$
Calcium (mg/dL)	9.35 ± 0.07	9.41 ± 0.10	9.52 ± 0.64	9.37 ± 0.13
Phosphorus (mg/dL)	6.41 ± 0.07	6.49 ± 0.04	6.58 ± 0.06	6.42 ± 0.03
Sodium (mmol/L)	$132.39^{a} \pm 1.54$	$139.79^{b} \pm 1.14$	$147.71^{c} \pm 1.15$	$133.85^{a} \pm 0.65$
Potassium (mmol/L)	$5.15^{a} \pm 0.06$	$5.46^{b} \pm 0.10$	$5.84^{c} \pm 0.08$	$5.20^{a} \pm 0.05$
Iron (µg/dL)	101.94 ± 1.55	102.24 ± 0.92	103.80 ± 0.75	102.28 ± 1.08
Zinc (µg/dL)	80.70 ± 0.84	81.02 ± 1.01	82.41 ± 0.67	80.62 ± 0.72

The means bearing different superscripts within a row differ significantly ($p<0.05$).

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