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The Effect of Pen Colour and Increased Photoperiod on Performance of Weaned Gilts

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Authors' contributions

This work was carried out in collaboration between both authors. Authors OVA and OAA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Both authors managed the analyses of the study, the literature searches and read and approved the final manuscript.

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ABSTRACT

This study was conducted to evaluate the effect of colour and increased photoperiod on performance, rectal and body temperature of weaned gilts. Forty cross bred (largewhite x landrace) weaned gilts at 8 weeks with an average weight of 7.70 kg ± 0.07 kg were randomly allotted into four housing colours consisting of a control; (T1: grey colour and normal day length (12 h), while T2, T3 and T4 contained red, blue and green coloured housing, respectively with increased photoperiods of 12, 15 and 18 h. Each treatment was replicated four times. The experimental design was 3x4 factorial arrangements in a completely randomised design. Feed intake and body weight gain were measured weekly throughout the 8 weeks of the experiment. The main effect of pen colour showed that there were significant variations (P<0.05) for final weight of weaned gilt

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with values ranging from 14.15 ± 0.34 kg (T3) to 18.18 ± 1.46 kg (T2). The same was observed for average weight gain per week (0.91 ± 0.05 kg to 1.48 ± 0.21 kg) and feed conversion ratio (FCR) 2.65 ± 0.26 to 3.49 ± 0.17, respectively. The main effect of photoperiod has significant difference in the final weight, with weaned gilts in 12 h having the highest value of (17.00 ± 0.95 kg) compared to those that were under 15 h (14.82 ± 0.66 kg) and 18 h (13.88 ± 0.26 kg) of lighting. The results also showed that there are significant differences in the average body and rectal temperature across the treatments with the values ranging from the least 37.08±0.19℃ (T1) to highest 37.74 ± 0.20℃ (T2) and rectal temperature 39.25 ± 0.11℃ (T4) to 39.62 ± 0.08℃ (T3), respectively. It was observed that gilts in the T3 had the lowest respiratory rate value of 39.80 ± 1.01 breaths/minute while the T1 had the highest value of 42.10 ± 1.86 breaths/minute. It can be concluded from this study that pen colour has an effect on the performance attributes of weaned gilts and increasing the photoperiod will not result in better performance hence, 12 h of lighting is sufficient for increased weight gain in weaned gilts.

Keywords: Colour; performance; photoperiod; temperature – humidity index; weaned gilts.

1. INTRODUCTION

Light is a key environmental factor that influences and directs physiological processes in all animals. In swine production, temperature and light are viewed as major environmental factors affecting animal physiology [1] with temperature being considered the most important factor. Pigs have dichromatic vision; in the pig's eye there are two sets of cones that give the animal peak wavelength sensitivity at 439 nm (blue colour) and 556 nm (green colour). The photoreceptors in a pig's eye cannot detect the colour red (>650 nm) [2,3]. Taylor [4] talked about night lighting in piggeries, this is sometime necessary, but studies on circadian rhythms in mammals have shown that even minor deviations in the intensity and duration of environmental light at a given time of the day can alter or disrupt various chronobiologic rhythms.

Pigs have a wide angle of vision (310°) [5], thus, have a panoramic view of their surroundings. Pigs do respond to colour, e.g. the change in the colour of the handlers' uniform [6], but the presence of a particular photo pigment is a weak indicator of the information actually supplied by activation of this pigment. Tanida et al. [7] concluded that pigs can identify 'blue', but suggested that pigs discriminated blue from other colours on the basis of hue rather than brightness and may be red–green colour blind. In a study evaluating responses to water dispenser colour, Stelios et al. [8] reported that new-born pigs were not attracted to the green water dispensers and their behavioural reaction to red and blue was gender-driven. Females preferred the blue dispenser, visiting it more times than the males, while males preferred the red dispenser. Edge et al. [9] found no significant effect of trough colour (yellow, red, and black) on feed intake, average daily gain or feed conversion. Overall, it may be concluded that, although pigs have some ability to discriminate among colours, there is little information on the spectrum visible to pigs and even less on the impact of colour on pig behaviour [10]. This study was therefore designed to investigate the effect of primary colours (red, blue and green) and increased photoperiod and their interactions on the performance, respiratory rate, rectal and body temperature of weaned gilts.

2. MATERIALS AND METHODS

Forty gilts weaned at 8 weeks with average weight of 7.70 kg ± 0.07 kg cross bred of largewhite x landrace pigs were randomly allotted into four housing colours consisting of a control (T1: grey and normal day length (12 h), while T2, T3 and T4 contained red, blue and green coloured housing respectively with increased photoperiod of 12, 15 and 18 h. Each treatment was replicated four times with one animal per replicate. The experimental design was 3x4 factorial arrangements in a completely randomised design.

All pigs were individually penned in a dwarf-walled, well-ventilated, cement-floor building and the sides were raised with planks of 3 m to prevent the reflections of the coloured light rays into other pens. Electrification of the pens to be used for increased photoperiods was done with a compact fluorescent energy saver full spiral 18 w of 46 lumens per watt bulb installed according to the colour of the pen. Each pen, including the feeder and drinker was painted with glossy paint for durability and a brush was used for the painting. The pens remained empty for four

weeks before the weaned gilts were brought in to prevent any effect of the smell on the animals. The bulbs were suspended below the walls but above the animals to prevent reflections to other pens. On arrival, the weaned gilts were treated against internal and external parasitic infestation and randomly allotted to each of the treatments. The temperature and the relative humidity of the pens were taken to ensure that the weaned gilts were kept at their thermo-neutral zone. During the 8 weeks of the study, the animals were fed twice (morning and evening) to ensure the feeder do not go empty. Feed and water were provided in the various troughs. The performance data (feed intake, initial, final weight, weight changes and body weight gain), environmental, body and rectal temperature and respiratory rate of each animals were taken weekly. The feed conversion ratio was calculated from the average feed intake and the weight gain. The weaned gilts were given the same diet and the composition of the concentrate to meet the NRC requirements (Table 1).

Table 1. The gross composition of concentrate ration for weaned gilts

Ingredient	Percentage
Maize	46.75
Wheat offal	30.00
Groundnut cake	10.00
Full fat soya	10.00
Bone mean	1.50
Oyster shell	1.00
Premix*	0.25
Salt	0.5
Total	**100**
Calculated nutrients	
ME Kcal/Kg	2720.50
Crude Protein (%)	18.28
Calcium (%)	0.99
Phosphorus (%)	0.68
Lysine (%)	0.74
Methionine (%)	0.27
Fibre (%)	4.53

ME = Metabolisable energy

**Composition of premix per kg of diet: vitamin A:(12,000,000 i.u) ; vitamin D3 (2,500,000 i.u) ; vitamin E (30,000 mg); vitamin K3 (2,000 mg); vitamin B1 (2250 mg); vitamin B2 (6000 mg); vitamin B6 (4,500 mg); vitamin B12 (15 mcg); niacin (40,000 mg); pantothenic acid (15,000 mg); folic acid (1,500 mg); biotin (50 mcg); choline chloride (300,000 mcg); manganese (80,000 mg); zinc (50,000 mg); iron (20,000 mg); copper (5,000 mg); iodine (1,000 mg); selenium (200 mg); cobalt (500 mg); antioxidant (125,000 mg)*

A digital clinical thermometer was inserted into the rectum and used to take the readings of the rectal temperature and a non-contact infrared thermometer was used to take the body temperature.

Temperature and relative humidity of the pen was measured with the aid of a thermo-hygrometer which was suspended in the pen. The temperature –humidity index (THI) was calculated from the result of the ambient temperature and relative humidity as an indication of Heat stress index using the stated formula:

$$THI\ (℃) = 0.8T + (RH/100) \times (T-14.3) + 46.4$$

THI≥74 is safe, 74<THI<79 is critical, 79≤THI<84 is dangerous and THI ≥ 84 is emergency [11].

2.1 Statistical Analysis

Data from the experiment was analysed using the statistical analysis of variance (ANOVA) procedure of SAS [12] and significant level of p=0.05 was used. The treatment means were compared using the Duncan's Multiple Range Test option of the same software.

3. RESULTS AND DISCUSSION

The main effect of pen colour on performance characteristics of weaned gilts is presented in Table 2. The feed intake for weaned gilts in the T1 and T2 increased significantly compare to T3 and T4. Results of the feed intake indicated that weaned gilts in the T2 pen consume more feed (3.43 ± 0.15 kg), than those in the T4 and T3 (3.13 ± 0.12 kg and 3.10 ± 0.09 kg respectively) pens. There was a significant difference in weight gain of gilts in T2 (1.48 ± 0.21 kg) compared to the average mean observed for T1, T4 and T3 (1.04 ± 0.07 kg, 1.03 ± 0.54 kg and 0.91 ± 0.05 kg) respectively which were not different from each other. FCR values also revealed a significant reduction for gilt in T2 (2.65 ± 0.13) compared to their counterparts in T3 (3.49 ± 0.17) and T4 treatments (3.12 ± 0.18).

From the results obtained in Table 3, Final weight was significantly greater for weaned gilts exposed to a 12 h (17.00 ± 0.95 kg) photoperiod compared to 15 h and 18 h (14.82 ± 0.66 kg, and 13.88 ± 0.26 kg respectively). The weaned gilts in the 15 h and 18 h photoperiod gained the least weights of 1.04 ± 0.60 kg and 0.88 ± 0.23 kg respectively, while the weaned gilts in 12 h

photoperiod had appreciable weight gain of 1.32 ± 0.14 kg. The feed intake of the gilts under 12 h (3.64 ± 0.06 kg) photoperiod was significantly greater than 15 h (2.90 ± 0.03 kg) and 18 h (2.91 ± 0.04 kg). There was no significant variation observed in the feed conversion ratio with values ranging from 2.96 ± 0.22 for 15 h to 3.39 ± 0.15 for 18 h.

There was no significant difference between the interaction of time x colour in the initial weight ($p = 0.346$), final weight ($p = 0.146$), average weight gain ($p = 0.169$) and FCR ($p = 0.368$). Although, interaction between colour x time in relation to average weight gain of weaned gilts was not significant ($p = 0.169$), the effect of colour and time was significant ($p < 0.05$).

The body temperature of weaned gilts in T2 (37.74 ± 0.20°C) was significantly higher compare to those housed under other colours 37.26 ± 0.08°C (T3), 37.19 ± 0.10°C (T4), and 37.08 ± 0.19°C (T1). The rectal temperature of animals in T3 was also significantly greater in value 39.62 ± 0.08°C compare to others, T2 (39.52 ± 0.10°C) and T1 (39.52 ± 0.16°C) has the same value, while the weaned gilts in T4 treatment has the lowest rectal temperature 39.25 ± 0.11°C. There was no significant difference in respiratory rate across the treatments from T1 to T4, 42.10 ± 1.86, 41.85 ± 1.09, 39.80 ± 1.01 and 41.27 ± 1.86, respectively. Fig. 1 presents the temperature – humidity index of the Pen house which ranges from 77.8 to 82.4.

Table 2. The main effect of pen colour on performance characteristics of weaned gilts

Parameter	Colour				SEM
	T1 (grey)	T2 (red)	T3 (blue)	T4 (green)	
Initial weight/pig (kg)	7.75	7.82	7.73	7.54	0.06
Final weight (kg)	15.00^{b}	18.18^{a}	14.15^{b}	14.73^{b}	0.29
Weight gain (kg)	7.25^{b}	10.36^{a}	6.39^{b}	7.19^{b}	0.30
Average weight (kg) gain/pig/week	1.04^{b}	1.48^{a}	0.91^{b}	1.03^{b}	0.04
Average feed (kg) intake/pig/week	3.39^{a}	3.43^{a}	3.10^{b}	3.13^{b}	0.02
Feed conversion ratio	3.32^{ab}	2.65^{b}	3.49^{a}	3.12^{ab}	0.08

^{abc} means on the same line with different superscripts are significantly different ($p<0.05$)

Table 3. The main effects of increased photoperiod on performance characteristics of weaned gilts

Parameter	Time			SEM
	12 hrs	15 hrs	18 hrs	
Initial weight/pig(kg)	7.74	7.55	7.77	0.03
Final weight/pig(kg)	17.00^{a}	14.82^{b}	13.88^{b}	0.18
Weight gain(kg)	9.22^{a}	7.27^{b}	6.13^{b}	0.18
Average weight (kg) gain/pig/week	1.32^{a}	1.04^{b}	0.88^{b}	0.03
Average feed (kg) intake/pig/week	3.64^{a}	2.90^{b}	2.91^{b}	0.01
Feed conversion ratio	3.10	2.96	3.39	0.05

^{abc} means on the same line with different superscripts are significantly different ($p<0.05$)

Table 4. Interaction effect of pen colour and duration of photoperiod on performance of weaned gilts

Parameter	Colour	Time	Colour x time
Initial weight	0.406	0.778	0.346
Final weight	0.002	0.003	0.146
Average weight gain	0.003	0.003	0.169
Average feed intake	<.0001	<.0001	0.0507
Feed conversion ratio	0.023	0.117	0.368

Table 5. The effect of pen colour on temperature and respiratory rate of weaned gilts

Parameter	T1 (grey)	T2 (red)	T3 (blue)	T4 (green)	SEM
Av. body temp. (°C)	37.08[b]	37.74[a]	37.26[b]	37.19[b]	0.05
Av. rectal temp. (°C)	39.52[ab]	39.52[ab]	39.62[a]	39.25[b]	0.04
Respiratory rate (breath/min)	42.10	41.85	39.80	41.27	0.41

[abc] means on the same line with different superscripts are significantly different (p<0.05)

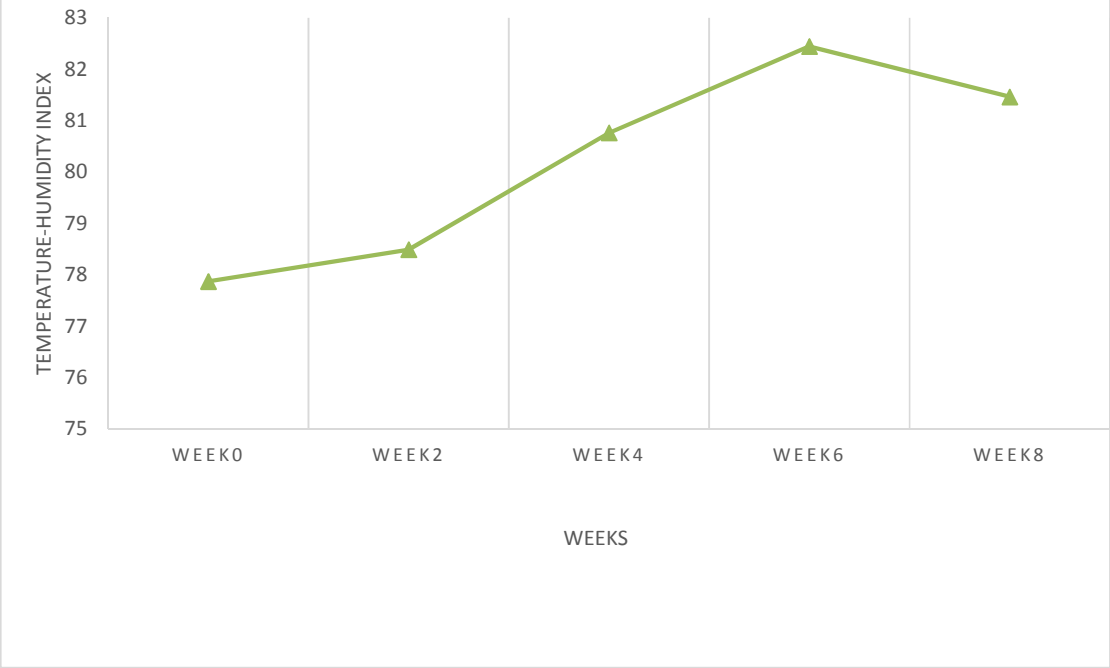

Fig. 1. Ambient temperature and humidity curve for the period of the experiment

The results of this study due to the effect of pen colour revealed a significant increase in feed intake of weaned gilts under T2 housing compared to those housed in other colours, this might be due to the active and investigative nature of animals under this treatment thus resulting in frequent visitation to the feeding trough. Feed conversion ratio was significantly affected by colour, this study disagrees with Edge et al. [9] who reported no significant variation in feed intake, weight gain and feed conversion ratio of pigs with differently coloured feeding troughs. Based on the FCR observed in this study which was significantly different despite the higher feed intake for animals in red housing, it could be deduced that weaned gilts are actually red-green colour sensitive which disagrees with Tanida et al. [7] whose report found that pigs can identify blue from other colours on the basis of hue rather than brightness and may be red-green colour blind.

Increasing photoperiod above the normal daylight affects the performance of these weaned gilts negatively when compared to the 12 h: the final weight and average weight gain decreases with increases in the photoperiod. These may be due to the increase in temperature which resulted from the increased photoperiod and cause a decrease in the feed intake and hence poor average weight gain because temperature and light are viewed as major environmental factors affecting animal physiology [1] with temperature being considered the most important factor.

These findings might have resulted from circadian rhythms which in mammals have shown even minor deviations in the intensity and duration of environmental light at a given time of the day and it can alter or disrupt various chronobiologic rhythms. The results obtained were consistent with the findings of

Christison et al. [13] which showed that piglets offered a choice of creep illuminances were more likely to select their home pen lighting, and that light itself was neither strongly attractive nor aversive to these animals at this stage.

At 12 h, the animals are instinctively used to the normal daylight and after feeding, the animals preferred to rest. However at 15 and 18 h, the active hours became elongated and the weaned gilts are engaged in all forms of activities thus, burning off the feed instead of resting in the pen. The FCR was not significantly different in all the photoperiods 12 h (3.10 ± 0.20) compare to 15 h (2.96 ± 0.22) and 18 h (3.39 ± 0.15). The lower FCR reflected better utilisation of feed.

The body temperature of the weaned gilts varied from 37.08 ± 0.19°C (T1) to 37.74 ± 0.20°C (T2) and rectal temperature from 39.25 ± 0.11°C (T4) to 39.62 ± 0.08°C (T3) but T1 and T2 had the same rectal temperature (39.52 ± 0.16°C). The same was also observed in the respiratory rate with pigs in the T1 having the highest value of 42.10 ± 1.86 breath /min. The THI showed that the animals were at a critical condition as reflected in the NOAA, 1976 reference for animal thermo neutral comfort zone. The THI for the period of the experiment ranges from 77 - 82.4, which is very high and it depicts that the animals are not in their comfort zone meaning the pigs are stressed and may be responsible for the lower feed intake.

4. CONCLUSION

It can be concluded from this study that pen colour has an effect on the performance attributes of weaned gilts and the red colour is most effective at improving performance. However, 12 h of lighting is efficient enough for increased weight gain in weaned gilts.

ETHICAL APPROVAL

All authors hereby declare that "Principles of laboratory animal care" (NIH publication No. 85-23, revised 1985) were followed, as well as specific national laws where applicable. All experiments have been examined and approved by the appropriate ethics committee.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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