Effect of Different Lighting Sources on Behavior and Growth of Weanling Pigs

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ABSTRACT : These studies aimed to determine how lighting might be used to improve feed intake and reduce aggressive behavior in newly weaned pigs. To examine whether this objective could be achieved an experiment was conducted to compare performance, behavior and body condition of weaners over 17-45 days, provided similar lighting quality (i.e. color temperature, color rendering index and lighting distribution) after weaning that piglets experienced prior to weaning. Triphosphor (TP) lighting to simulate daylight was provided during the day while at night, Pascal red (PR) lighting was provided to simulate the night-light piglets previously had received from infrared heating lamps. This treatment was compared to weaners provided conventional cool-white fluorescent light during the day only. Weaners on treatment lighting from 17-45 days of age showed no improvement in body weight or feed conversion at 24, 31, 38 and 45 days compared to the controls. There was, however, a significant improvement ($p<0.05$) in feed intake in the first week of weaning for weaners provided TP/PR lighting. Over the first 3 days of weaning, pigs on TP/PR lighting showed an increase ($p<0.05$) in the incidence of ear chewing but reduced ($p<0.05$) levels of nosing the abdomen of other pigs and reduced ($p<0.05$) occurrences of being stood on by other pigs. Females exhibited more ($p<0.05$) mounting and nosing behaviors and rubbing the heads of other pigs than males. On the other hand, males engaged in more ($p<0.05$) fighting, nipping, ear chewing and standing on other pigs compared to females. Pigs provided PR lighting on the first night of weaning engaged in higher ($p<0.05$) incidences of nosing and tail sucking behaviors, more ($p<0.05$) head thrusting, fighting and ear chewing compared to control pigs. The body condition of weaners provided the TP/PR lighting treatment was significantly poorer ($p<0.05$) compared to weaners on control lighting. In conclusion there was no improvement in production performance of weaners provided new technology lighting apart from the improvement in feed intake in the first week weaners were exposed to the TP/PR lighting. *(Asian-Aust. J. Anim. Sci. 2001. Vol. 14, No. 2 : 280-287)*

Key Words : Weaners, Lighting, Welfare, Behavior

INTRODUCTION

There has been a considerable international research effort aimed to improve post-weaning feed intake of weaners. Despite this, the problem of poor feed intake in weaners persists worldwide. It is well known that groups of newly weaned pigs from different litters are aggressive (Fraser, 1978; McGlone et al., 1987) and can spend up to a week (Graves et al., 1978) post-weaning establishing their dominance orders. The initial post-weaning period is commonly characterized by poor performance and is often referred to as the post-weaning growth check or lag (Mahan and Lepine, 1991). A number of factors including weaning age, weaning weight, weaning stress, health status, low feed intake, diet composition, digestive immaturity and environment have all been implicated as potentially influencing the duration of this growth restriction lag (Mahan and Lepine, 1991). There have been extensive research conducted on nutritional and husbandry strategies to improve weaner performance but there has been only scant investigation of lighting techniques to modify behavior in pigs reported in the literature. Most experiments have not been successful. Bearss et al. (1974) reported that nursing pigs from birth to 6 or 12 weeks of age in continuous complete darkness were generally less active but not different in body weight than pigs reared in a 12:12 light:dark cycle. McGlone et al. (1988) reported no differences in post-weaning feed intake or weight gain for photoperiods of 1:23 or 16:8 light:dark for pigs that were weaned in the morning. Christison (1996) also reported no difference in behavior patterns and performance of pigs weaned in morning and provided 5 lux or 100 lux. Cool-white light and daylight were more effective in stimulating early puberty than red light (Wheelhouse and Hacker, 1982) but there is no information on the effect of new technology lighting on growth and feed intake in pigs. Poultry remain calmer when provided blue or green light (Prayitno et al., 1997) yet in many farms situations both pigs and poultry are provided red light early in life from infrared heat lamps.

While light treatment has differential effects on mood and cognition in humans (Michalon et al., 1997), phototherapy using day light tubes is increasingly being used by practitioners to treat a range of stress conditions in humans including depression (Partonen and Lonnqvist, 1997). The use of light therapy to relieve depression in patients is

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dependent on the functional integrity of the brain serotonin system, which results in depression. Pigs also may suffer depression at weaning. Puppe et al. (1997) suggests that newly weaned pigs have more problems coping with the unfamiliar housing environment than coping with unfamiliar pigs. Maintaining similar light quality (i.e. color temperature, color rendering index and lighting distribution, Takeuchi et al., 1994) and patterns might be necessary when pigs are moved to weaner, grower and finisher facilities.

There are a number of new light sources available on the market. One is the Triphosphor (TP) high-grade fluorescent light, which produces a light environment, which is natural in colour and not distorted and the Pascal red (PR) light produces a similar colour to the light produced by infrared heat lamps used in the farrowing shed. There is a drastic change in the light environment of pigs at weaning. It is hypothesised that a gradual reduction in the night photoperiod using an energy efficient Pascal red light at night and providing a Triphosphor high-grade fluorescent light during the day could minimise the effects on weaners as a result of the change in the light environment. To test this hypothesis behavior, feed intake and growth was measured on weaners exposed to the lighting sources for 4 weeks after weaning.

MATERIALS AND METHODS

Location and treatments

Weaner housing

The experiment was conducted in the weaner facility of the commercial piggery at the Pig and Poultry Production Institute located at the Roseworthy Campus, University of Adelaide, 60 km north of Adelaide and 10 km east of Gawler in South Australia. The weaning facility comprised 4 rooms each with 6 pens of 15 weaners. Flooring was half slat, half-concrete with feeders and nipple waterers. At weaning, environmental temperatures in the rooms were maintained initially at 28-30℃ for 17 day-old weaners with a gradual decline to 20-22℃ by 45 days of age. Thermostatically controlled fans circulated warm air from strip heaters on the wall.

Lighting in weaner rooms

Each weaner room had 4 single cool-white fluorescent tubes installed at ceiling level with natural light entering room via small louvred windows. Two rooms were fitted with alternative lighting; the other 2 rooms had the control lighting (i.e. cool-white fluorescent lighting from 07:30-16:30 h and some daylight entering rooms through small louvred windows). The experiment examined the effect of maintaining similar lighting quality for piglets after weaning that they experienced prior to weaning. To achieve this 4 double fluorescent fittings were installed into each of the 2 light treatment rooms. One of the tubes in each fitting was a NEC 37W Triphosphor (TP) daylight tube and the other was a NEC 37W Pascal red (PR) tube. The TP light was on during the day while at night the PR light simulated the light from the infrared lamps weaners had received during the suckling period. At sunset, light was switched from the TP day light tube to the PR fluorescent. A programmable time clock was installed to control the lighting throughout the weaning period in all rooms. This removed the need for daily changing or setting of the time clock. The lighting program at weaning initially provided 24 hours of light with a gradual reduction in the amount of PR light to achieve a natural daily light pattern by the end of weaning. Light intensity in the control and treatment rooms varied from 10-110 lux depending on the amount of natural light entering the room. At night the Pascal red light intensity was 3 lux.

Simulation of preweaning lighting

A total of 360 weaned piglets were used in this study. Weaned pigs had *ad libitum* access to water and 22% CP wheat based diet. For the experimental phase (17-45 days of age) there were 2 light treatments; TP/PR versus control lighting from cool-white fluorescent tubes. There were 2 replicates per treatment, each replicate a single room comprising 3 pens of 15 female piglets/pen and 3 pens of 15 male piglets/pen. Mortality, feed intake, weight gain and feed conversion were determined weekly over 17-45 days of age. Soon after weaning at 17 days and at 45 days every pig was scored for severity of body cuts, scratches, bites and bruises to assess the extent of agonistic interactions. The experiment was repeated and data pooled to increase the statistical power of the experiment.

Behavior studies

Video cameras recorded pig behavior over the following periods; firstly, for the first 3h after mixing on day of weaning and for 3 h on day 3 after weaning and secondly for 3 h at night when PR light was provided on day of weaning and day 3 after weaning. A closed circuit infrared television system was used to record behavior of pigs under PR lighting conditions. An infrared illuminator was used to improve the quality of video recordings obtained at night especially for the control group (no light). Remote operation of camera control equipment and video recorders from a caravan outside the weaner rooms ensured weaners were not influenced by operator presence. From the videotapes 5 female and 5 male focal weaners using the method of Lehner (1996) were observed for each replicate. All social (mounting, mounted, rubbing heads and nosing abdomen), harmful social (nosing other pigs, being nosed, tail biting, tail bitten, tail sucking and tail sucked) and aggressive behaviors (giving head thrusts, receiving head thrusts, biting, bitten, fighting, nipping, fighting to feed, standing on, stepped on, ears chewed, and chew ears) were recorded. A reduction in harmful social and aggressive behaviors of pigs provided modern lighting would be interpreted as being beneficial for pig welfare.

Body condition

The 1-4 scoring system (1: poor; 4: good) used for assessing the severity of body cuts, scratches, bites and bruises in both experiments was as follows; Score 1. Body part with excessive levels of cuts, scratches, teeth marks and bruising; Score 2. Body part with moderate levels of cuts, scratches, teeth marks and bruising; Score 3. Body part with small levels of cuts, scratches, teeth marks and bruising; and score 4. Body part with no evidence of cuts, scratches, teeth marks and bruising.

Statistical analyses

Base SAS software (SAS Institute, 1988) was used to perform analysis of variance (by GLM procedure) to determine the main effects of lighting source, sex, period and hour of weaning on feed intake, body weight, feed conversion, social and aggressive behaviors and body condition score of weaners. Interactions between the main effects were also analysed. Duncans Multiple Range test (l.s.d.) was used to separate treatment means. The no apparent difference between treatment means for some values reported despite l.s.d. being shown is due to rounding of values to 2 decimal points.

RESULTS

Feed intake, body weight and feed conversion in weaners over 17-45 days

Pigs weaned at 17 days and provided TP/PR lighting over 17-45 days showed no improvement in body weight or feed conversion at 24, 31, 38 and 45 days (table 1). There was, however, a significant improvement in feed intake ($p<0.05$) in the first week of weaning for weaners provided TP/PR lighting. There were no sex differences in production performances of weaners over 17-45 days. Mortality was sporadic. There was insufficient data to enable a meaningful analysis of mortalities to be undertaken.

Behavior

Effect of lighting treatment

Weaners on TP/PR lighting showed an increase in the incidence of ear chewing but reduced levels of receiving shoulder thrusts and nosing at the abdomen of other pigs. There was also a reduction in the occurrences of pigs being stood on by other pigs (tables 2 and 2a).

Sex

Females exhibited more mounting, nosing behaviors and rubbing the heads of other pigs compared to males (table 2). On the other hand, males engaged in more fighting, nipping, ear chewing, being stood on and standing on other pigs compared to females (table 2).

Table 1. Effect of lighting (TP/PR vs Control) and sex on feed intake, body weight and feed conversion (feed: gain) in weaners over 17-45 days

	BWT 17D (kg)	BWT 24D (kg)	BWT 31D (kg)	BWT 38D (kg)	BWT 45D (kg)	FI 17-24D kg/pig	FI 24-31D kg/pig	FI 31-38D kg/pig	FI 38-45D kg/pig	FI 17-45D kg/pig	FCE 17-24D (g/g)	FCE 27-31D (g/g)	FCE 31-38D (g/g)	FCE 38-45D (g/g)	FCE 17-45D (g/g)
Treat															
TP/PR	6.169	6.561	8.316	11.048	16.327	1.133	2.054	3.321	5.097	11.605	2.89	1.12	1.21	1.00	1.14
Control	6.373	6.826	8.507	11.469	16.044	0.865	1.963	3.569	5.485	11.882	1.91	1.17	1.20	1.19	1.22
l.s.d.	NS	NS	NS	NS	NS	0.23	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sex															
Female	6.232	6.639	8.499	11.218	16.082	0.991	2.093	3.447	5.472	12.003	2.43	1.12	1.27	1.13	1.22
Male	6.311	6.748	8.324	11.299	16.289	1.007	1.925	3.443	5.111	11.486	2.30	1.22	1.16	1.03	1.16
l.s.d.	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

TP/PR=Triphosphor and Pascal red lighting.

BWT17D, 24D, 31D, 38D and 45D=Body weight at 17days, 24 days, 31 days, 38 days and 45 days respectively.

FI 17-24D, 24-31D, 31-38D, 38-45D=Feed intake in first, second, third and fourth week of weaning respectively.

FCE 17-24D, 24-31D, 31-38D, 38-45D, 17-45D=Feed conversion in first, second, third, fourth week of weaning and overall feed conversion respectively.

l.s.d.=least significant difference ($p<0.05$).

NS=not significant in analysis of variance ($p>0.05$).

Period of weaning

There was an increase in the incidence of most behaviors in the first three hours of weaning compared to the other 3 periods (tables 2 and 2a). The exception to this was the fighting that occurred between pigs when accessing the feeder. This fighting was significantly greater on the third day of weaning compared to all other periods.

Hour of filming

There was an increased incidence of most behaviors in the first hour of filming over all the periods that filming was undertaken (tables 2 and 2a).

Sex × treatment interactions

Males showed a greater incidence (events/pig/h) of giving head thrusts (0.72 vs 0.43) and receiving head thrusts (0.79 vs 0.57) under TP/PR lighting (table 3). This contrasted with the females, which had an increased level of giving head thrusts (0.73 vs 0.58) and receiving head thrusts (0.81 vs 0.64) under control lighting compared to males on TP/PR lighting. Males engaged in greater incidence of fighting (1.58 vs 0.98) and nipping (1.45 vs 0.94) under TP/PR lighting compared to control lighting while for females there was an increase in fighting (1.02 vs 0.85) and nipping (0.82 vs 0.71) under control lighting relative to TP/PR lighting.

Period of weaning × treatment interactions

There were some important treatment × period of weaning interactions (table 4). Pigs provided PR lighting on the first night of weaning engaged in higher incidences (events/pig/h) of nosing other pigs (3.57 vs 2.55), being nosed (3.63 vs 2.44), tail sucking (0.11 vs 0.02) and tail being sucked (0.06 vs 0.01) compared to control lighting. The PR group was also observed to engage in significantly more head thrusting (0.76 vs 0.26) and receiving head thrusts (0.75 vs 0.43), fighting (1.36 vs 0.45), nipping (1.26 vs 0.33), ear chewing (2.88 vs 0.64) and ears being chewed (1.41 vs 0.55) compared to control pigs on the first night of weaning. In contrast the weaners provided control lighting engaged in more shoulder

Table 2. Effect of lighting (TP/PR vs Control), sex, period after weaning and hour of filming on incidence of pig behaviors (Value in table is average of incidences occurring over 1 hour)

	MT	MTG	RH	NT	NO	BND	TBITE	TBITN	TSUK	TSKD	GHT	RHT	BIT	BITN	FITE	NIP	FTF
Treat																	
TP/PR	0.01	0.07	0.20	0.10	3.17	3.47	0.03	0.02	0.05	0.03	0.66	0.69	0.48	0.54	1.00	1.08	0.07
Control	0.11	0.10	0.24	0.16	3.03	3.39	0.03	0.02	0.06	0.05	0.59	0.71	0.52	0.51	1.22	0.88	0.07
l.s.d.	NS	NS	NS	0.06	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Sex																	
Male	0.004	0.04	0.04	0.18	3.29	3.51	0.03	0.03	0.05	0.04	0.54	0.65	0.58	0.56	1.21	1.13	0.05
Female	0.14	0.13	0.13	0.25	2.95	3.33	0.03	0.01	0.06	0.05	0.68	0.75	0.43	0.48	0.96	0.78	0.09
l.s.d.	0.09	0.06	0.06	0.07	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.23	0.21	NS
Period																	
Wean-day 0	0.14	0.07	0.42	0.20	5.05	6.17	0.04	0.04	0.08	0.08	1.35	1.55	1.40	1.41	2.86	2.41	0.00
Wean-day 3	0.15	0.22	0.25	0.20	3.58	3.88	0.03	0.03	0.07	0.08	0.59	0.61	0.21	0.24	0.80	0.73	0.24
Night-day 0	0.01	0.04	0.12	0.15	2.94	2.89	0.02	0.01	0.05	0.03	0.45	0.55	0.38	0.39	0.63	0.64	0.00
Night-day 3	0.00	0.03	0.03	0.03	0.91	0.73	0.01	0.00	0.00	0.00	0.05	0.07	0.04	0.03	0.04	0.05	0.04
l.s.d.	0.13	0.09	0.10	0.09	0.59	0.50	NS	0.02	0.04	0.41	0.20	0.20	0.22	0.19	0.33	0.30	0.06
Hour																	
1st h of film	0.13	0.20	0.35	0.20	4.34	4.91	0.04	0.03	0.08	0.09	0.83	0.93	0.63	0.61	1.40	1.24	0.07
2nd h of film	0.04	0.03	0.15	0.11	2.53	2.75	0.01	0.00	0.04	0.03	0.54	0.64	0.50	0.52	1.00	0.86	0.08
3rd h of film	0.04	0.03	0.14	0.13	2.48	2.61	0.03	0.02	0.03	0.02	0.47	0.53	0.38	0.42	0.85	0.77	0.06
l.s.d.	NS	0.08	0.09	0.08	0.51	0.43	0.02	0.02	0.04	0.03	0.18	0.18	0.19	0.16	0.29	0.26	NS

TP/PR=Triphosphor and Pascal red lighting.

MT=mounted, MTG=mounting, RH=rubbing heads, NT=nosing abdomen, NO=nosing other, BND=being nosed, TBITE=tail biting, TSUK=tail sucking, TSKD=tail sucked, GHT=give head thrusts, RHT=receive head thrusts, BIT=biting, BITN=bitten, FITE=fight, NIP=nipping, FTF=fight to feeder.

Comparisons using l.s.d.=least significant difference ($p<0.05$) should be made within columns and within main effects.

NS=not significant in analysis of variance ($p>0.05$).

1st, 2nd and 3rd h of film=first, second and third hour of a filming session at weaning and at sunset on day of weaning and 3 days after weanig.

Table 2a. Effect of lighting (TP/PR vs Control), sex, period after weaning and hour of filming on incidence of pig behaviors (Value in table is average of incidences occurring over 1 hour)

	SO	STO	ECH	CHE	GST	RST	NUZZ	CHT	TCH
Treat									
TP/PR	1.61	1.89	1.46	1.26	0.01	0.01	0.02	0.04	0.03
Control	1.48	2.39	1.12	1.09	0.04	0.05	0.05	0.06	0.03
l.s.d.	NS	0.26	0.22	NS	NS	0.03	NS	NS	NS
Sex									
Male	1.70	2.29	1.37	1.28	0.03	0.05	0.04	0.05	0.02
Female	1.36	1.92	1.13	1.02	0.03	0.03	0.04	0.06	0.03
l.s.d.	0.23	0.25	0.21	0.22	NS	NS	NS	NS	NS
Period									
Wean-day 0	2.23	3.90	2.83	2.75	0.09	0.10	0.10	0.05	0.04
Wean-day 3	1.32	1.39	1.08	0.86	0.01	0.01	0.03	0.10	0.05
Night-day 0	1.73	2.27	1.03	0.90	0.01	0.02	0.03	0.03	0.01
Night-day 3	0.86	0.74	0.08	0.10	0.00	0.01	0.01	0.05	0.01
l.s.d.	0.32	0.36	0.30	0.31	0.37	0.41	0.05	0.05	0.04
Hour									
1st h of film	1.51	2.39	1.75	1.53	0.04	0.04	0.08	0.09	0.03
2nd h of film	1.58	1.88	1.09	1.05	0.03	0.05	0.02	0.05	0.02
3rd h of film	1.51	1.97	0.90	0.88	0.02	0.01	0.02	0.03	0.03
l.s.d.	NS	0.31	0.26	0.27	NS	0.03	0.04	0.04	NS

TP/PR=Triphosphor and Pascal red lighting.
SO=standing on, STO=stepped on, ECH=ear chewed, CHE=chew ears, GST=give shoulder thrust, RST=receive shoulder thrust, NUZZ=gentle nuzzling of other with mouth, CHT=chew trotter, TCH=trotter chewed.
Comparison using l.s.d.=least significant difference ($p<0.05$) should be made within columns and within main effects.
NS=not significant in analysis of variance ($p>0.05$).
1st, 2nd and 3rd h of film=first, second and third hour of a filming session at weaning, at sunset on day of weaning and 3 days after weaning.

thrusting (0.13 vs 0.02) and nuzzling (0.16 vs 0.01) in the first 3 hours of weaning compared to the PR group.

Body condition

Effect of lighting treatment

The body condition of weaners provided the TP/PR lighting treatment was significantly poorer than weaners on control lighting were (table 5). The left and right ear, neck and genitals were the particular areas of the body that were affected in the pigs provided TP/PR lighting.

Sex

The overall body condition of females was poorer (table 5) with males having a significantly better score on the right face and left front leg.

Age

At 45 days of age the overall body condition of pigs did not improve. The left ear, right face, back, tail and rump were the body parts, which showed deterioration in condition by 45 days. On the other hand there was an improvement in body score of the chest, abdomen and left front leg (table 5).

Lighting treatment × sex interactions

Males on control lighting had an improved body condition of their chest and right back leg relative to females, while the condition of the genitals was inferior in males relative to females on TP/PR lighting (table 6).

Table 3. Interaction of sex × lighting treatment (TP/PR vs Control) on incidence of pig behaviors (values in table are average of incidences occurring over 1 hour)

Behavior	Control		TP/PR		l.s.d.
	Male	Female	Male	Female	
GHT	0.43	0.73	0.72	0.58	0.15
RHT	0.57	0.81	0.79	0.64	0.15
FITE	0.98	1.02	1.58	0.85	0.23
NIP	0.94	0.82	1.45	0.72	0.21
ECH	1.11	1.13	1.79	1.12	0.21
TCH	0.03	0.02	0.00	0.05	0.03

TP/PR=Triphosphor and Pascal red lighting.
ECH=ears chewed, FITE=fight, NIP=nipping, TCH=trotter chewed, GHT=give head thrusts, RHT=receive head thrusts.
Comparison using l.s.d.=least significant difference ($p<0.05$) should be made within a row.

Lighting treatment × age interactions

From 17-45 days there was a decline in body score condition of the left ear, right ear and tail of weaners on TP/PR lighting compared to control lighting (table 7).

Sex × age interactions

Females had a poorer body score at 45 days of age on the right face and tail compared to males which did not show a decline in condition of these body parts (table 8).

DISCUSSION

These studies were undertaken to improve feed intake, body weight, feed conversion and reduce body lesions in weaners provided TP/PR. This was not achieved although there was an improvement in feed intake in the first week that weaners were provided TP/PR lighting. Presumably the PR light provided at

Table 4. Interaction of period of weaning × lighting treatment (TP/PR vs Control) on incidence of pig behaviors (value in table is average of incidences occurring over 1 hour)

Behavior	Control				TP/PR				l.s.d.
	Day 0	Day 3	Night 0	Night 3	Day 0	Day 3	Night 0	Night 3	
NO	5.53	3.69	2.55	0.90	4.25	3.37	3.57	0.92	0.59
BND	6.89	3.69	2.44	0.55	4.97	4.24	3.63	1.03	0.50
TSUK	0.10	0.08	0.02	0.01	0.04	0.04	0.11	0.00	0.04
TSKD	0.10	0.10	0.01	0.00	0.03	0.04	0.06	0.00	0.04
GHT	1.39	0.61	0.26	0.06	1.27	0.54	0.76	0.03	0.21
RHT	1.57	0.67	0.43	0.07	1.53	0.52	0.75	0.06	0.21
FITE	2.86	0.63	0.45	0.05	2.82	0.64	1.36	0.03	0.33
NIP	2.38	0.63	0.33	0.05	2.82	0.64	1.36	0.03	0.30
SO	2.36	1.26	1.43	0.86	2.01	1.41	2.21	0.84	0.33
ECH	2.78	1.00	0.64	0.06	2.90	1.74	2.88	0.83	0.30
CHE	2.82	0.84	0.55	0.12	2.62	0.88	1.41	0.04	0.32
GST	0.13	0.01	0.01	0.01	0.02	0.00	0.01	0.00	0.37
NUZZ	0.16	0.01	0.03	0.00	0.01	0.04	0.01	0.00	0.04

NO=nosing other, BND=being nosed, TSUK=tail sucking, TSKD=tail sucked, GHT=give head thrusts, RHT=receive head thrusts, FITE=fight, NIP=nipping, SO=standing on, CHE=chew ears, GST=give shoulder thrust, NUZZ=gentle nuzzling of other with mouth.

Comparison using l.s.d.=least significant difference ($p<0.05$) should be made within a row only.

Table 5. Effect of lighting (TP/PR vs Control), sex and age on body score in weaners (1, =poor body condition; 4, =good body condition)

	LE	RE	LF	RF	NECK	CHEST	ABD	BACK	GEN	TAIL	RUMP	LFL	RFL	LBL	RBL	AVE
Treat																
TP/Pascal R	3.09	3.08	3.97	3.95	3.65	3.99	3.89	3.74	3.99	3.96	3.95	3.78	3.77	3.90	3.91	3.77
Control	3.28	3.26	3.97	3.97	3.75	3.99	3.87	3.74	3.98	3.98	3.95	3.75	3.77	3.90	3.91	3.81
l.s.d.	0.05	0.06	NS	NS	0.05	NS	NS	NS	0.01	NS	NS	NS	NS	NS	NS	0.02
Sex																
Female	3.18	3.16	3.97	3.94	3.71	3.99	3.88	3.74	3.99	3.98	3.94	3.73	3.77	3.89	3.90	3.78
Male	3.18	3.18	3.96	3.98	3.69	3.99	3.89	3.74	3.98	3.96	3.96	3.81	3.78	3.91	3.92	3.80
l.s.d.	NS	NS	NS	0.02	NS	NS	NS	NS	0.01	NS	NS	0.05	NS	NS	NS	0.01
Age																
17 days	3.21	3.19	3.96	3.98	3.71	3.99	3.79	3.88	3.98	3.99	3.97	3.74	3.75	3.90	3.90	3.80
45 days	3.15	3.14	3.97	3.94	3.69	4.00	3.99	3.59	3.99	3.94	3.92	3.80	3.80	3.90	3.92	3.79
l.s.d.	0.05	NS	NS	0.02	NS	0.008	0.08	0.05	NS	0.02	0.02	0.04	NS	NS	NS	NS

TP/PR=Triphosphor and Pascal red lighting.

LE=left ear, RE=right ear, LF=left face, RF=right face, ABD=abdomen, GEN=genitals, LFL=left front leg, RFL=right front leg, LBL=left back leg, RBL=right back leg, AVE=average score for all body parts.

Comparison using the l.s.d.=least significant difference ($p<0.05$) should be made within a column and within a main effect.

NS=not significant in analysis of variance ($p>0.05$).

Table 6. Interaction of sex × lighting treatment (TP/PR vs Control) on body score condition

Body part	Control		TP/PR		l.s.d.
	Male	Female	Male	Female	
Chest	3.98	4.00	4.00	3.90	0.01
Genitals	3.99	3.99	3.96	4.00	0.01
RBL	3.90	3.91	3.93	3.87	0.03

GEN=genitals, RBL=right back leg.
Comparison using the l.s.d.=least significant difference ($p<0.05$) should be made within a row only.

Table 7. Interaction of period of weaning × lighting treatment (TP/PR vs Control) on body score condition

Body part	Control		TP/PR		l.s.d.
	17 days	45 days	17 days	45 days	
LE	3.27	3.27	3.15	3.02	0.05
RE	3.26	3.28	3.13	3.02	0.06
TAIL	3.98	3.96	4.00	3.92	0.02

LE=left ear, RE=right ear.
Comparison using the l.s.d.=least significant difference ($p<0.05$) should be made within a row only.

Table 8. Interaction of period of weaning × sex on body score condition

Body part	Male		Female		l.s.d.
	17 days	45 days	17 days	45 days	
RF	3.97	3.98	3.98	3.91	0.02
TAIL	3.99	3.96	3.99	3.92	0.03

RF=right face.
Comparison using the l.s.d.=least significant difference ($p<0.05$) should be made within a row only.

night stimulated the weaners to eat more, but this was accompanied by an increase in the incidence of aggressive behaviors which culminated in a poorer body condition score for weaners by 45 days. PR lighting was provided to pigs at night to simulate the lighting from infrared lamps provided to pigs during the suckling stage. Red lighting may encourage more aggressive interaction amongst pigs. Other light colours may have been more effective. It was important to note that the fighting to access the feeder occurred more on day 3 of weaning than day 1. This indicates that for this trial the early social conflicts were more to do with pigs resolving the social hierarchy rather than competing for feed.

Tryptophan concentration in the brain can limit the serotonin synthesis (Seve et al., 1991) which is implicated in altering the emotional status of pigs. In humans serotonin synthesis can be influenced by light therapy (Partonen and Lonnqvist, 1997) and hence to explain the results of the current pig trial reference to the human literature is relevant. There has always been a sense of mystery and scepticism about the influence light has on behavior in humans although in recent years phototherapy has been used to treat a range of stress conditions in humans including depression (Partonen and Lonnqvist, 1997). Physiological mechanisms to explain the role of light in improving these conditions are gradually being elucidated. The use of light therapy to relieve depression in patients appears to be dependent on the functional integrity of the brain serotonin system (Partonen and Lonnqvist, 1997).

In weaners there is very scant information on the possible role of light in growth and behavior in weaners. The results from this trial have probably only further increased the mystery and scepticism associated with light therapy in piglets. There were however some interesting findings that need to be addressed. Overall the pigs exposed to TP/PR undertook few incidences of nosing the abdomen of other pigs and receiving shoulder thrusts but were stepped on more often and had their ears chewed more often. The observation was made that TP lighting during the day tends to make the skin of pigs look pinker in color than the cool white fluorescent tubes. This could attract the pigs to chew the ears and step on other pigs while they engaged in this behavior. It is possible that TP lighting could divert attention of other pigs away from the lower body area to upper body areas like the ear. This comment is tempered by the observation that females engaged in more fighting under cool white fluorescent lighting compared to males, while males fought more than females under TP/PR lighting. There may be potential therefore for modifying aggressive behavior of males and females with different light sources. This aspect requires further investigation.

Alternatively was it the colour of light per se or the fact that light was provided almost continuously in the first week of experiment 1 that stimulated feed intake but increased aggressive behaviors in weaners? Cool-white light and daylight can be more effective in stimulating early puberty in pigs than red light (Wheelhouse and Hacker, 1982) although studies by McGlone et al. (1988) suggested that photoperiod has no influence on feed intake and weight gain. This suggests that red light at night stimulated the increase in feed intake observed in the present study. Weaners on TP/PR lighting in the experiment were provided continuous lighting on the first day of weaning reducing by approximately 20 minutes per day so that by 45 days no night-light was being provided to pigs. The quantity of light provided was programmed to reduce on a daily basis as weaning progressed. In retrospect it may have been a better strategy to provide continuous red light throughout weaning, because feed intake in the first week was initially higher for the TP/PR group but then declined relative to the control group. It was apparent that the main differences in the body condition for pigs provided the TP/PR light was for poorer condition on the neck and ears. It is unlikely that poorer body condition of the neck and ears in these areas is likely to lead to a rejection of the carcass or to initiate secondary infection (M. Moore, pers. comm., South Australian Pig Health Monitoring Scheme). This would be more of a concern for lesions on the hindquarters. While there was a minor deterioration in the condition of the tails from 17-45 days of age there was no significant difference in body weight as a result of this condition for the treatment groups and thus economic value of pigs at this age would still be similar.

In the meantime however pig producers are faced with the dilemma of continuing to utilise lighting sources which are not efficient and have higher power usage. The important aspect to note is that that the light intensity from one TP tube at floor level directly under the light source is similar to 2 equivalent wattage cool-white light fluorescent tubes. The power costs of the continuous operation of one TP tube is $35A/annum compared to two cool-white light fluorescent tubes ($76A/annum) based on 12c/KiloWattHour (KWH) for peak usage (14h/day), 6.1c/KWH (10 h/week day and all weekend). Further studies are required with a variety of alternative light sources that are now available on the market so that sound guidelines can be provided to industry on type and distribution of lights in pig sheds and any possible effects on performance, behavior and health.

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