cent lean of carcass while an increase in carcass length was associated with an increase in percent lean of carcass. Increased marbling and fat content were associated with a decrease in loin eye area and total moisture and an increase in firmness. No appreciable relationships were found between fat content and percent lean of carcass.

The Effects of Heat Stress on Rectal Temperatures and Respiration Rates in Gilts

Roger Bates, R. A. Battaglia and I. T. Omtvedt

In the spring of 1970, 24 Hampshire gilts averaging 7 months of age and averaging 208.9 pounds were confined to a cool or hot chamber for a one-week period (2 gilts/chamber/week) to determine the effects of heat stress on rectal temperatures and respiration rate. Both environmental control chambers were also evaluated for capabilities and limitations. When gilts were first subjected to the chambers, both chambers were operated at 70°F. with 60 percent humidity and 5 m.p.h wind velocity. Twenty hours after each group of pigs was confined to the chambers, the temperature in one chamber was elevated to 80°F. and then four hours later elevated to 85°F. and held at that level for the remainder of the confinement period.

The desired chamber temperatures and humidity in the hot chamber were obtained. However, humidity in the cool (70°F.) chamber was affected by increased air moisture content outside the chamber.

Exposure to the chambers tended to induce estrus. Ten gilts (4 in cool chamber and 6 in hot chamber) showed signs of estrus on either days 3 or 4 of confinement. The average rectal temperature for pigs in the cool chamber was 102.4°F. compared to 103.0°F. for those in the hot chamber. As chamber temperature increased rectal temperatures and respiration rates increased. The pigs exposed to the hot chamber had higher average rectal temperatures than the cool chamber pigs at all periods except at 10:30 a.m. on day 5. Some adaptation to heat stress was apparent on the 4th or 5th exposure day. The daytime average respiration rates for those exposed to heat stress tended to decrease with length of exposure. However, the average daytime high rectal temperature for gilts in the hot chamber was higher ($P<.01$) in the cool chamber on day 2, 3, 4 and 5 of confinement. Both groups exhibited lower average rectal temperatures at 6:30 a.m. each day accompanied by an elevation after feeding.

Based on these results it may be desirable to increase wind velocity above 5 m.p.h. or to install a larger dehumidification system when low chamber temperatures are desired. This study indicates that pigs exhibit a diurnal rectal temperature rhythm in an environment where temperature, humidity, wind velocity and lighting are held relatively constant and that animals tend to show some adaptation to heat approximately 48 to 72 hours after initial exposure.

Introduction

With an increase in confinement rearing of swine, the effects of heat stress on the physiological well-being and performance of swine is of increased concern to the swine producer. Most of the heat stress research has been conducted with facilities that are capable of controlling only temperature. Due to lack of adequate environmental control facilities there is limited data on the effects of constant temperature, humidity and wind velocity on swine.

Many reports indicate that swine will exhibit an increase in rectal temperature and respiration rate upon initial exposure to high temperature. Work done by Edwards *et al.* (1968) at Fort Reno suggests that gilts appear to adapt to high temperatures after about 6 days exposure.

This study was undertaken to investigate the effects of a constant elevated temperature on the rectal temperature and respiration rate in pigs. Since this was the first study involving the new environmental control chambers at the University Science Building, an additional objective was to evaluate the capabilities and practical limitations of these facilities.

Materials and Methods

This study utilized 24 Hampshire gilts with an average age of 7 months and weighing 208.9±2.9 pounds confined for a one-week period (2 gilts/chamber/week) to either a cool or hot environmental control chamber. These chambers were constructed inside a closed room at the

Veterinary Science Building. Each chamber was equipped with a restraining crate designed to accommodate two 200 pound pigs. These chambers were designed and constructed by Lab-Line Environeers, Division of Lab-Line Instruments, Inc., Melrose Park, Illinois.

One chamber served as a control chamber and was maintained at approximately 70°F., 60 percent relative humidity and 5 m.p.h. wind velocity continuously. The other chamber was operated at 70°F. for 24 hours after initial gilt exposure and was then elevated to 80°F. and then four hours later increased to 85°F. and held at that level for the remainder of each week of confinement. Chamber lighting was continuous for the entire period of gilt confinement. The chambers and restraining crate designs and dimensions are presented in Figures 1, 2 and 3, respectively.

Each gilt was fed 4 pounds of a growing ration at 6:30 a.m. each day and water was supplied *ad libitum*. Rectal temperatures were determined with a large animal rectal thermometer after a 3 minute insertion period. Respiration rates per minute were obtained by counting flank movements. Rectal temperatures and respiration rates were taken at 6:30 p.m. and 10:30 p.m. on day 1, at 6:30 a.m., 10:30 a.m., 2:30 p.m., 6:30 p.m and 10:30 pm on day 2, 3, 4 and 5, and at 6:30 am. and 10:30 a.m. on

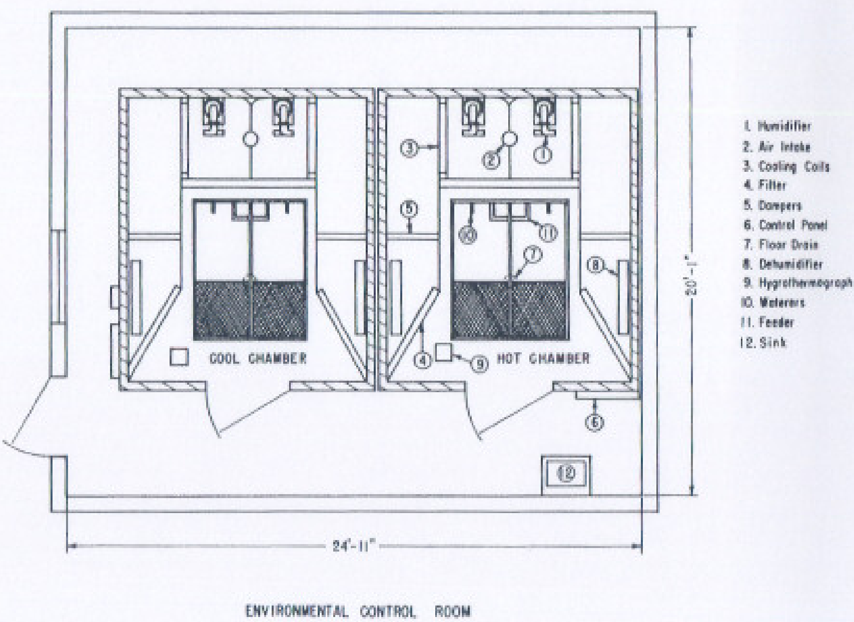

Figure 1. Environmental control room showing location of environmental chambers, restraining crate position and work area.

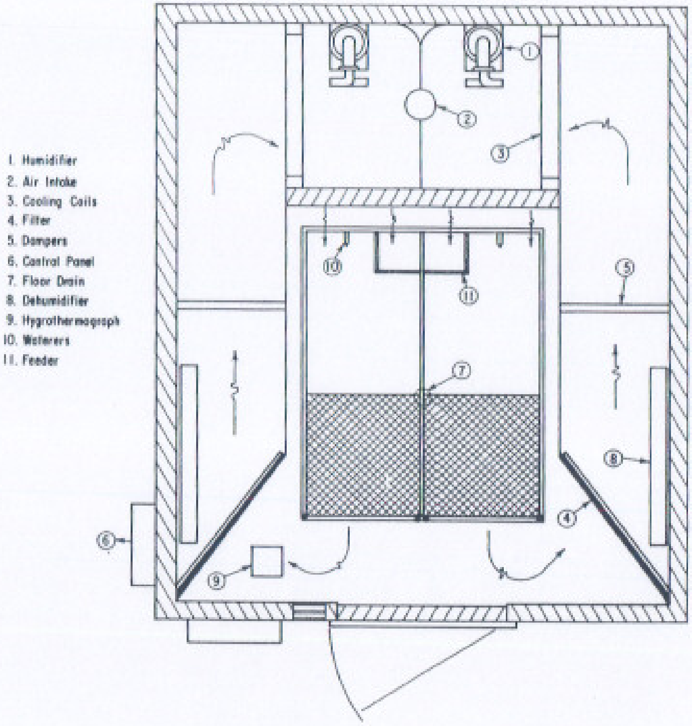

Figure 2. Environmental chamber showing restraining crate and environmental equipment.

day 6 for each week of pig confinement. Chamber temperatures and humidities were also obtained at these same times from a continually operating hygrothermograph recorder located inside each chamber.

Results and Discussion

The means and standard deviations for the cool and hot chamber temperatures and relative humidities are given in Table 1.

Chamber temperatures and the hot chamber humidities were relatively constant during this experiment. However, the dehumidification system in the 70°F. chamber was operating at full capacity during the entire study. In weeks two and four fluctuations in humidity were noted which possibly resulted from increased air moisture outside the chamber. It was possible to control humidity at 60 percent in the hot chamber

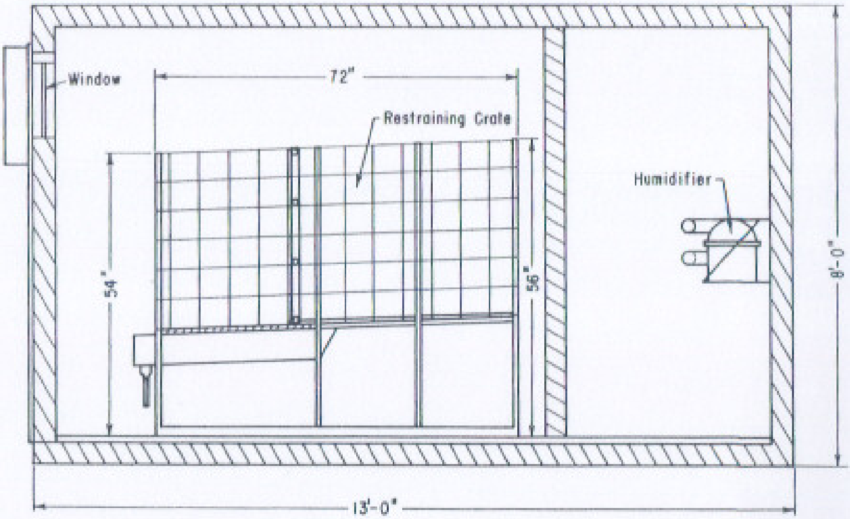

Figure 3. Cross section of environmental chamber showing restraining crate design.

Table 1. Means and Standard Deviations for Chamber Temperature and Relative Humidity

Chamber	Temperature (°F.) Mean	St. Dev.	Relative Humidity (%) Mean	St. Dev.
Cool	69.9	0.86	61.5	2.74
Hot	84.8	0.49	60.3	1.41

because the high temperature was a supplement to the dehumidification system. This suggests that the environmental facilities would be relatively inefficient in obtaining relative humidities below 60 percent in the 70°F. environment used in this study. However, the 5 m.p.h. wind velocity for this experiment could have been too slow to circulate sufficient air through the dehumidifier. In future trials where low temperatures and humidities are desired it may be desirable to increase wind velocity above 5 m.p.h. or install a larger dehumidification system.

One gilt exposed to the hot chamber during the fourth week exhibited abnormally high rectal temperatures and respiration rates and was subsequently eliminated from this study. Four gilts in the cool chamber and 6 gilts in the hot chamber were observed to be in estrus on either the third or fourth day of confinement. This increased incidence of estrus may have resulted from the environmental change and the physical stress of moving to the chamber location. Nalbandov (1964) noted that more pigs when moved will exhibit estrus within 5 to 8 days than would have in their original location.

As chamber temperature was increased to 85°F., rectal temperatures and respiration rate increased. The average cool and hot rectal temperatures were 102.4°F. and 103.0°F., respectively. A temperature of 102.4°F. is considered normal for pigs. The 103.0°F. average hot rectal temperature suggests that these gilts were in an environment above their comfort zone.

The average cool chamber and hot chamber gilt rectal temperatures are presented by time intervals in Figure 4. This figure indicates that a diurnal rectal temperature rhythm was exhibited by pigs in both chambers with lows occurring at 6:30 a.m. daily. Average rectal temperature increases were observed for both gilt groups after feeding at 6:30 a.m. each day. The control gilts tended to be more active and to consume their feed prior to the 10:30 a.m. reading, while the hot chamber pigs were observed to be eating over a 24 hour period. The gilts in the hot chamber appeared to adapt to heat stress about the fourth or fifth confinement days as evidenced by non-significant differences between the rectal temperatures of the cool and hot groups.

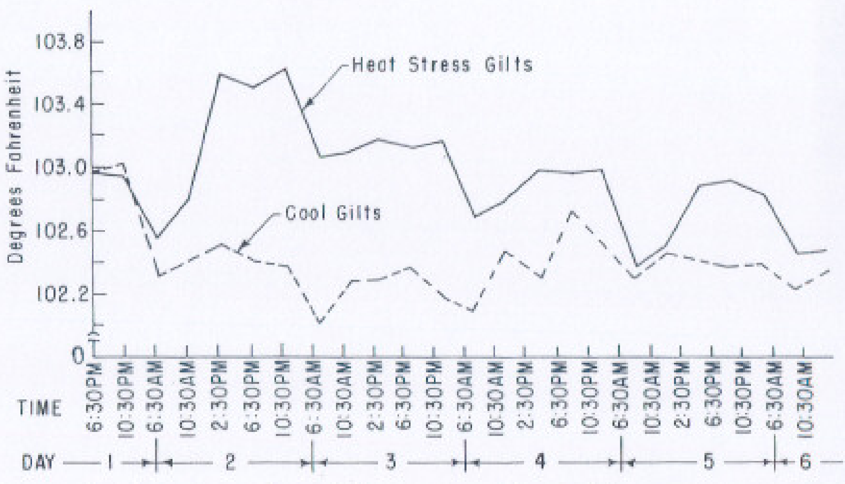

Figure 4. Average cool and heat stress gilt rectal temperature comparisons at different stages of confinement.

Both gilt groups exhibited average high rectal temperatures at 2:30 p.m., 6:30 p.m. or 10:30 p.m. on days 2, 3, 4 and 5 of the confinement period. These rectal temperatures were averaged to obtain a daytime high rectal temperature and are presented in Figure 5. Average daytime high hot rectal temperature was significantly ($P<.01$) higher than the average daytime cool rectal temperature for either day 2, 3, 4 or 5 of exposure. The greatest reduction in rectal temperatures for heat stress gilts occurred from day 2 to 3 of confinement. The increase for average daytime high cool rectal temperature on day 4 was possibly the result of the four cool chamber gilts coming into estrus on the fourth confinement day and exhibiting rectal temperature increases. This response was not evident among the hot chamber pigs although six gilts did show signs of estrus on either the third or fourth confinement day.

The cool and hot chamber gilt average respiration rates are presented by time intervals in Figure 6. As chamber temperature was increased to 85°F. the average respiration rate for the hot chamber pigs was higher ($P<.01$) than the average respiration rate for those pigs in the cool environment at every time period for the remainder of the week. However, there was a trend for the daytime high average hot chamber gilt respiration frequency to decrease with length of exposure.

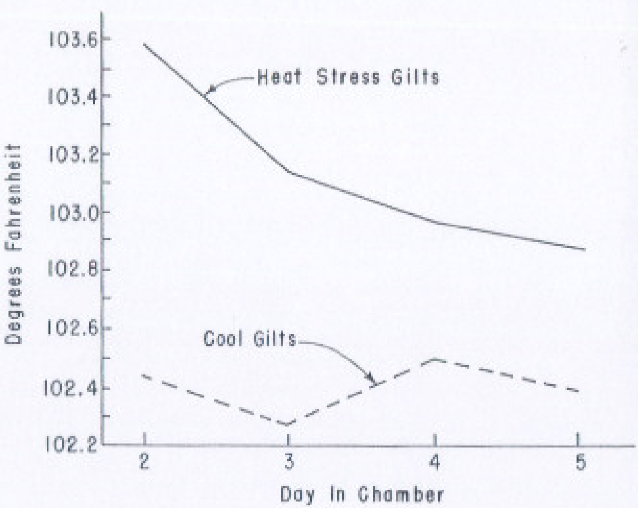

Figure 5. Average daytime high (2:30, 6:30 and 10:30 p.m.) rectal temperature comparisons for cool and heat stress gilts on days 2, 3, 4 and 5 of confinement.

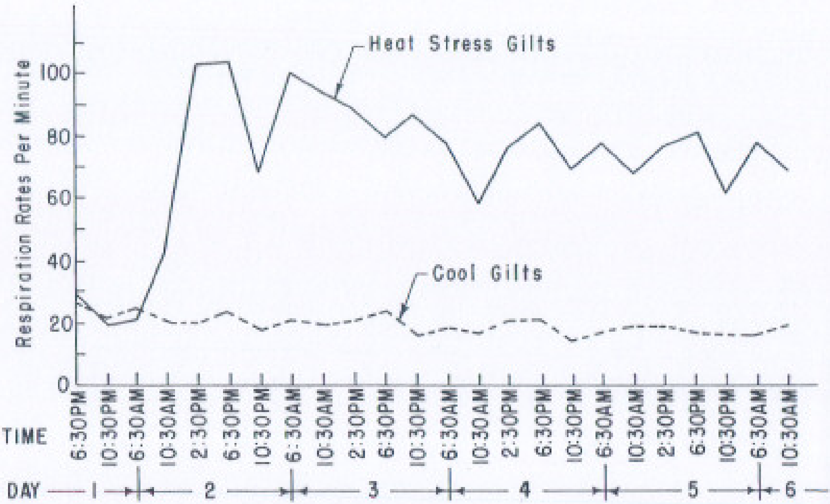

Figure 6. Average cool and heat stress gilt respiratin rate per minute comparisons at different stages of confinement.

There was also a tendency for both gilt groups to exhibit daytime fluctuations in average respiration rates.

Literature Cited

Edwards, R. L., I. T. Omtvedt, E. J. Turman, D. F. Stephens and G. W. A. Mahoney. 1968. Reproductive performance of gilts following heat stress prior to breeding and in early gestation. J. Anim. Sci. 27:1634.

Nalbandov, A. V. 1964. Reproductive Physiology (2nd Ed.), W. H. Freeman and Company, San Francisco.