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SWINE RESPONSE TO MISTING SYNCHRONIZED WITH MEAL EVENTS

R. A. Eigenberg, J. A. Nienaber, G. L. Hahn, S. D. Kachman

ABSTRACT. *Prior work has shown that the tympanic temperature of swine increases during an eating bout. An experiment was conducted in a hot environment using timing of misting as a way of reducing the body temperature during meal events. Three treatments were applied to pigs in a constant temperature 30° C environment: no misting, misting just prior to meals, and misting between meals. Two response variables were examined: feed intake and meal duration. Three environmental chambers were used in a Latin-Square layout with each chamber hosting each treatment. Analysis showed feed intake was significantly ($P < 0.05$) increased by misting just prior to the meal, when compared with no misting or misting between meals. Similarly, meal duration was significantly greater ($P < 0.05$) for misting just prior to the meal than for the other two treatments. The meal effect appears to result from cooling the pig, thereby reducing the tympanic temperature spike that normally occurs during an activity event such as a meal. The moderation of the body temperature apparently allows the pig to eat for a greater period of time before thermoregulatory controls restrict the meal duration and hence the meal amount. While not conclusive from these short-term observations, increased feed intake should benefit growth performance.*

Keywords. *Feed intake, Meal duration, Synchronization, Misting.*

Adverse effects of environmental conditions on livestock growth performance are minimized when air temperatures can be maintained within an optimal range. Maintaining near-optimal temperatures in cold weather is less of a problem in modern swine housing than cooling the facility during hot periods. Natural ventilation, with curtains on the sidewalls, provides some environment modification, but summertime temperatures often exceed heat stress thresholds for growing-finishing (G-F) swine (Nienaber et al., 1993), resulting in potential performance penalties (Hahn and Nienaber, 1988). Evaporative cooling is one method of reducing heat stress and maintaining production potential. Misting of the animals, a form of evaporative cooling, has the advantage of being localized to allow for zone control, but raises the question of when to apply the mist.

The overall goal of this research was to demonstrate the need to consider the physiology of the animal, in addition to the housing constraints, when using misting for improved swine performance. Specific objectives for this work were to identify the impact of misting synchronized to meal events on feed intake and on meal duration.

BACKGROUND

Researchers have shown that high environmental temperatures adversely affect swine feed intake rates and subsequent growth rates. Nienaber et al. (1987) found feed conversion was most efficient for G-F swine (45 to 85 kg) between 20 and 25°C, with a substantial decrease in feed efficiency above 25°C. A research summary by Hahn et al. (1987) reported a reduction of feed consumption above 25°C for both growers and finishing pigs. A 21-day study of barrows and gilts demonstrated that G-F hogs consumed less feed and grew more slowly when housed in a hot diurnal temperature (22.5 to 35°C) environment than pigs in a constant 20°C thermoneutral environment (Lopez et al., 1991). Morrison et al. (1975) found that a 27.5°C mean temperature resulted in a lower rate of gain for pigs under either constant or cyclic conditions. Not only is performance impacted, but physiological changes occur also. Bond et al. (1967), as well as Roller and Goldman (1969), observed that rectal temperatures, respiration rates, and pulse rates increase in response to elevated environmental temperatures. These physiological changes indicate that animal dynamics are linked to heat-stressing environments.

Dynamic physiological changes as evidenced in short-term transient responses of pigs to high environmental temperatures have been observed. Hahn et al. (1993) reported that tympanic temperature records have been shown to be a relatively sensitive measure for assessing thermoregulatory responses to environment. A related report (Eigenberg, 1994) documented a close association among feed intake, heat production, and tympanic temperature, as illustrated for a pig in a hot (28°C) environment (fig. 1). Examination of figure 1 reveals a linkage between meal events and heat production spikes as generated by activity events, primarily eating events. These individual tympanic temperature spikes have been examined in some detail. The rate of increase of tympanic temperature during the meal (Eigenberg et al.,

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zNames are necessary to report factually on available data; however, the USDA neither guarantees nor warrants the standard of the product, and the use of the name by USDA implies no approval of the product to the exclusion of others that may also be suitable.

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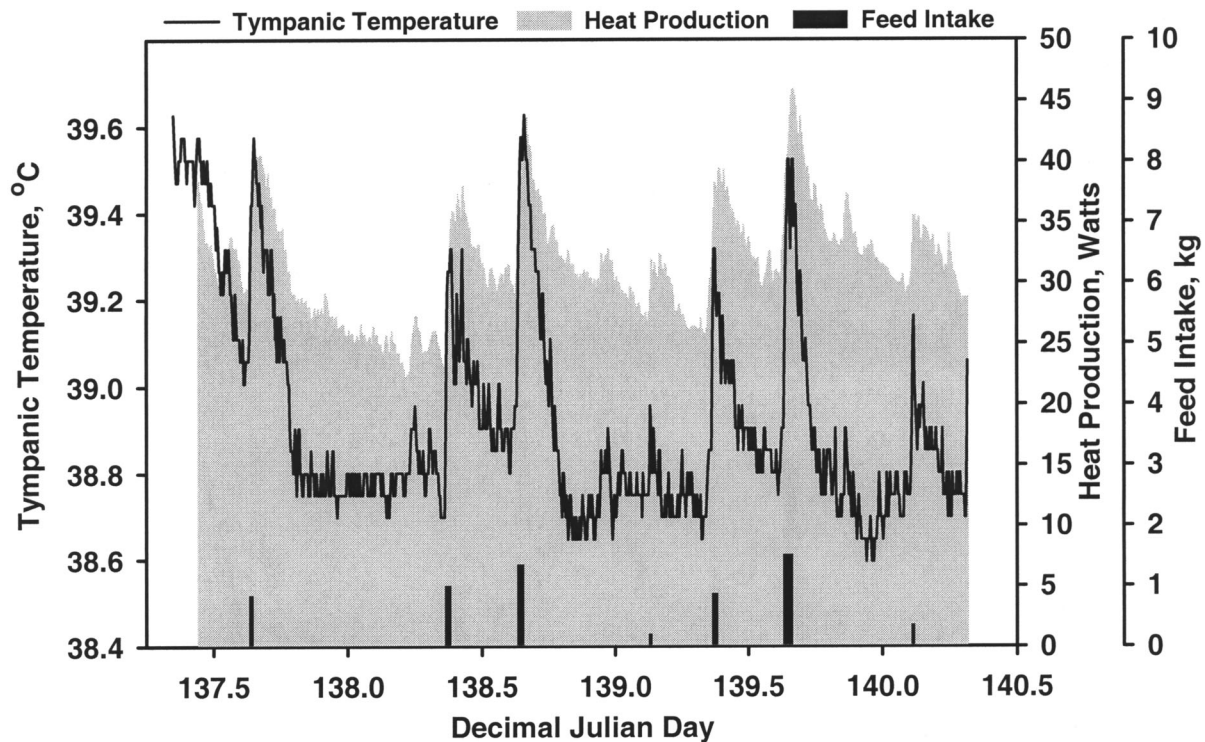


Figure 1. Feed intake, tympanic temperature, and heat production for an 80-kg pig during indirect calorimeter runs at constant hot (28°C) ambient temperature (Eigenberg, 1994).

1997) and the rate of decline following the meal (Eigenberg et al., 1995) provide clues about the animal's environment based on the animal's tympanic temperature response surrounding a meal. Following on that understanding, the next logical step might be to modify the local environment of the pig in such a way as to impact specific dynamic responses such as those occurring during a meal event. One such approach is wetting the animal by misting or spraying in synchronization with meal events to limit the temperature rise resulting from the activity-induced temperature rise on animals in hot environments.

Misting has been tested (Panagakis et al., 1996; Morrison et al., 1979; Givens et al., 1974) and modeled (Gates et al., 1991; Turner et al., 1997), demonstrating it to be an effective method to reduce heat load during peak summertime temperatures in swine facilities. While misting to reduce air temperature has benefits, there are some drawbacks, including associated maintenance of misting equipment and the need to conserve water in many areas of the country; also, misting/spraying increases the wastewater that needs to be dealt with. Additionally, to realize the full benefit of misting, the building humidity should be minimized. Gates et al. (1991) describes a misting management strategy that minimizes interior Temperature-Humidity Index (THI). Maintaining minimum THI by controlling misting allows the optimum evaporative cooling to be achieved in the building.

Using misting or sprinkling to wet the animals directly improves evaporative cooling efficiency, as the evaporative process occurs at the skin's surface, rather than cooling the air that in turn cools the animal. Incorporating the physiological response of swine at high temperatures provides additional insight into ways to minimize misting. For example, misting only during those events that are most likely to raise

the body temperature of the pig, namely the eating event, could reduce total misting time and maintain a lower THI within a livestock facility, thereby further improving the overall effectiveness of misting.

MATERIALS AND METHODS

Eighteen randomly selected lean crossbred U.S. Meat Animal Research Center (USMARC) barrows (no littermates), with beginning weights of approximately 70 kg, were used for this experiment. The pigs were individually penned in three environmental chambers at USMARC with six pens per chamber. Temperature and humidity was controlled in each chamber by air passing over cooling coils saturated at the desired dew point temperature with an air exchange occurring every minute (Nienaber and Hahn, 1983). Three treatments were applied to the pigs in a constant 30°C temperature environment: 1) no misting, 2) misting just prior to meals, and 3) misting between meals. The chambers were maintained at a relative humidity of 50% with minimal air movement at the pen level.

The misting nozzle/pressure combination was predetermined by a series of wetting tests. The desired criterion was to achieve complete wetting of the pig in a 5-min duration, and was accomplished by a single 11.4 L/h (3 gph) at 4.4-kilopascal (40-psi) nozzle [operated at approximately 9.4 kilopascal (65 psi)], located 1.2 m above the each pen floor. Each bank of nozzles for each chamber was controlled by computer-activated solenoids. The control strategy was to operate the misters for a period of 5 min either just prior to a meal or equally spaced between meals.

Meal access was also computer-controlled using solenoids to lock lids on each feeder, with access allowed at 0200,

0800, 1400, and 2000 hours for a duration of 45 min. Meal amounts and meal duration were monitored by load cells (Nienaber et al., 1996). Water was supplied *ad libitum*. Lights were on from 0600 to 1800 hours daily.

The experiment was designed as a Latin Square with three treatments, three chambers, and three treatment periods. The treatment period duration was 10 days, and was divided into two segments (sequence): 1) first three days of the treatment and 2) remaining seven days of the treatment. The two segments within the treatment allow adaptation effects to be examined. Multiple meals by multiple pigs within chambers were analyzed as repeated measures reducing the data to chamber means for each of the response variables: 1) meal duration and 2) meal amount. Statistical comparisons were made using the SAS (SAS, 1985) procedure PROC GLM.

RESULTS AND DISCUSSION

Treatments were imposed for a total of 30 days, with chambers set to 30°C for the duration of that period. In the third week of the study, four pigs developed a fever and were withdrawn from the experiment. As a result of the illness, the initial population of six pigs/chamber was reduced to five in chambers 1 and 3 and to four in chamber 2. The remainder of the population appeared to maintain health throughout the experiment.

Feed intake did not show an adaptation (sequence) effect ($P > 0.05$), nor was there any interaction of treatment by chamber or treatment by sequence. An anticipated effect of time was observed, with older pigs eating more. Mean feed intake per meal data are shown in table 1. Feed intake for misting just prior to a meal was significantly greater than no misting ($P = 0.01$) and was greater than misting between meals ($P = 0.009$). There was no impact of misting between meals ($P > 0.05$) on feed intake per meal as compared to no misting.

The meal duration showed no effect of adaptation (sequence) ($P > 0.05$) and no interaction of treatment by sequence. There was an effect of treatment by chamber ($P < 0.05$), suggesting a strong pig effect as revealed in a significant ($P < 0.05$) chamber effect. Table 2 shows a treatment effect ($P < 0.05$) on meal duration. Misting just prior to the meal resulted in the longest duration meals and was greater than no misting ($P = 0.0006$) or misting between meals ($P = 0.0001$). Meal duration for misting between meals was different from no misting ($P < 0.05$).

Misting prior to a meal caused a significant increase in both meal quantity and duration. This outcome, combined with prior studies showing strong associations of tympanic temperature spikes and meal events, gives evidence that the observed results are primarily due to a moderation of body temperature rise at the meal event. Additionally, limited data are available from a previous experiment operating under a similar protocol in which tympanic temperatures were taken.

Table 1. Feed intake during meal opportunity, means by treatment, n = 18.

Treatment	Mean (kg) ^[a]	Std. Err. (kg)
No mist	0.623 ^a	±0.029
Prior to meal	0.701 ^b	±0.031
Between meals	0.619 ^a	±0.015

^[a] Treatment means with same letter are not different ($P > 0.05$).

Table 2. Time spent eating during meal opportunity, meal duration by treatment, n = 18.

Treatment	Mean (h/meal) ^[a]	Std. Err. (h/meal)
No mist	0.233 ^a	±0.018
Prior to meal	0.263 ^b	±0.010
Between meals	0.210 ^c	±0.005

^[a] Treatment means with same letter are not different ($P > 0.05$).

Difficulty with the tympanic sensors resulted in dropping that measure from the study. A segment of collected data from that study (fig. 2) shows tympanic records from a pig under the treatment that underwent misting just before the meal followed by the treatment with no mist at all. The tympanic temperature mean for no mist was 39.5°C, as compared to 39.3°C for mist prior to a meal opportunity. This slight average body temperature change is accompanied by an apparent visual change in the dynamic pattern of the record. While the data are very limited, they also support an effect on body temperature caused by the misting protocol. The combined evidence is convincing that meal events are limited to some degree by internal body temperature spikes (Eigenberg et al., 1994) and the impact of the generated temperature spikes can be moderated by management practices such as misting.

SUMMARY AND CONCLUSION

Fourteen crossbred growing–finishing barrows with a starting weight of approximately 70 kg underwent tests to observe the performance effect of misting synchronized with meal events. Three misting strategies were compared: 1) misting just prior to a meal, 2) misting between meals, and 3) no misting. The air was held at 30°C and 50% relative humidity. Two response variables were considered: 1) meal intake and 2) meal duration. The treatments impacted both response variables ($P < 0.05$) with greater meal intakes and greater meal duration means as a result of misting just prior to a meal event. The meal effect appears to result from cooling the pig, thereby reducing the tympanic temperature spike that normally occurs during an activity event such as a meal. The moderation of the body temperature apparently allows the pig to eat for a greater period before thermoregulatory controls restrict the meal duration and hence the meal amount. While not conclusive from these short–term observations, increased feed intake should benefit growth performance.

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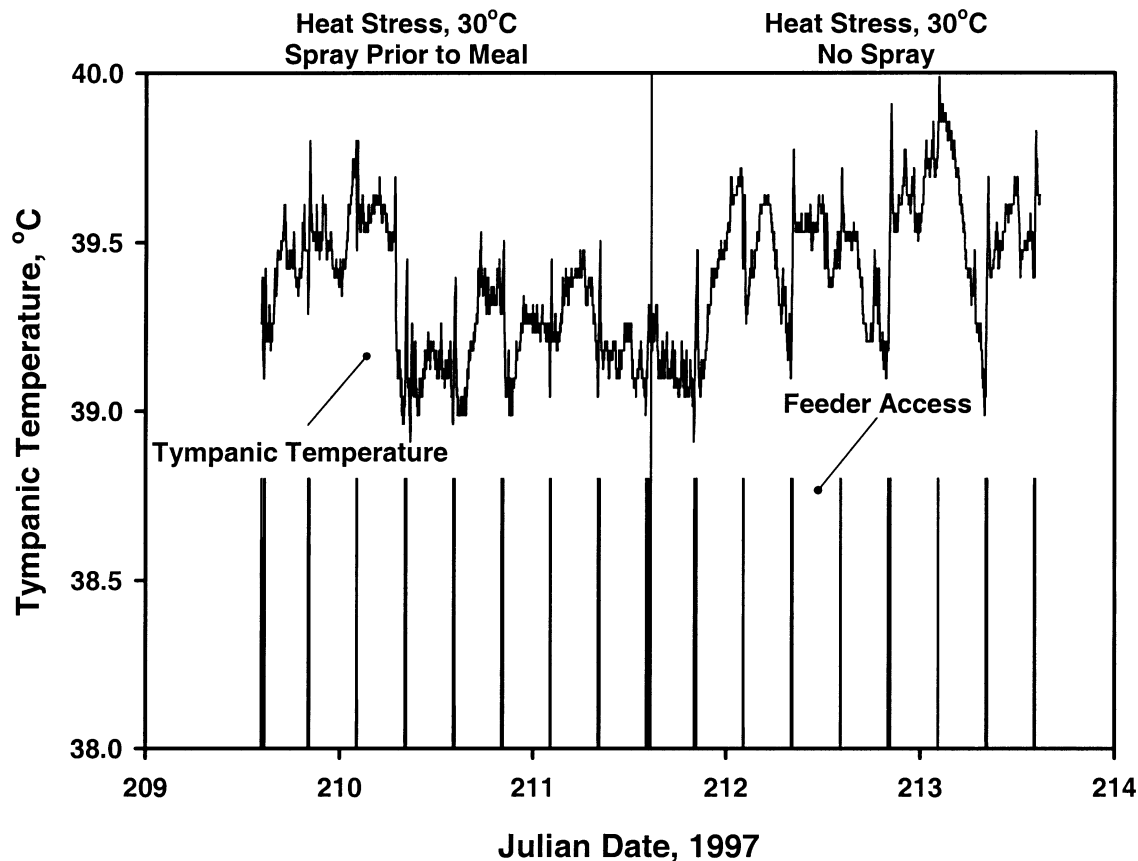


Figure 2. Tympanic temperature of a 118-kg pig with misting 5 min prior to meal (mean temperature 39.3°C) compared with no misting (mean temperature 39.5°C).

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