Proceedings of the European Conference on Agricultural Engineering AgEng2018

8-12 July, 2018
Wageningen, The Netherlands

Organised and published by:
Wageningen University and Research

Proceedings of the European Conference on Agricultural Engineering AgEng2018

Edited by
Prof. Dr. P.W.G. (Peter) Groot Koerkamp
Dr. C. (Kees) Lokhorst
Ir. A.H. (Bert) Ipema
Dr. C. (Corné) Kempenaar
Dr. C.M. (Karin) Groenestein
C.G. (Casper) Van Oostrum
N.J. (Nardy) Ros

Cite as:

Groot Koerkamp, P.W.G., Lokhorst, C., Ipema, A.H., Kempenaar, C., Groenestein, C.M., van Oostrum, C.G., and Ros, N.J., 2018. Proceedings of the European Agricultural Conference, 8-12 July, Wageningen, the Netherlands. Wageningen: Wageningen University and Research.

Published by:
Wageningen University & Research

Papers from the bi-annual European conference on agricultural engineering held at Wageningen Campus as official event of the European Society of Agricultural Engineering (EurAgEng), Wageningen, the Netherlands, 8-12 July 2018. Abstracts of this conference can be found in a separate publication on the website http://www.eurageng.eu/

PO Box 16, NL-6700 AA, Wageningen, The Netherlands
https://doi.org/10.18174/471679
Also available from www.eurageng.eu

Not printed

Animal Welfare Indicators in Growing and Fattening Pigs With Different Environmental Conditions

Vasco Fitas da Cruz[1], Rui Charneca[2], Teresa Morgado[3], Catarina Martins[4]

[1]ICAAM, Department of Rural Engineering, University of Évora. vfc@uevora.pt

[2]ICAAM, Department of Veterinary Medicine, University of Évora, rmcc@uevora.pt

[3]ICAAM, Department of Rural Engineering, University of Évora. tsmorgado@uevora.pt

[4] Department of Rural Engineering, University of Évora. m37287@alunos.uevora.pt

Abstract

The application of different technological innovations in the intensive systems of pig production has generated some problems related to health and animal welfare in modern facilities. To measure animal welfare is necessary to use a set of indicators (behavioural, physiological, productive and sanitary) capable of expressing the animals' adaptability to the environment. Temperature is one of the main components of the environment, since it influences the physiology, behaviour and productivity of the pigs. The aim of this study is to verify the adaptive evolution to different environmental conditions (winter, thermoneutrality and summer) in growing and fattening pigs through physiological, behavioural and productive indicators. Seven females with initial weight of 45kg were analysed throughout this test. The animals were housed in a room equipped with an environmental control system. The area per animal was 1.5 m^2. The environmental data collected were temperature, relative humidity and wind speed. The physiological parameters measured were body surface temperature, rectal temperature and salivary α-amylase. The feed intake was monitored through an individual feed machine equipped with animal weight scale. In order to monitor the behaviour of animals, video cameras and microphones were installed. The final weight of the animals was about 95 kg. The daily food intake and mean daily gain of live weight were 2.70 kg day^{-1} and 0.611 kg kg^{-1}; 2.51 kg day^{-1} and 0.947 kg kg^{-1} and 2.17 kg day^{-1} and 0.526 kg kg^{-1}, respectively in winter, thermoneutrality and summer. The corresponding values of body surface temperature were 25.4 ºC; 29.1 ºC and 34.0 ºC and the concentration of salivary α-amylase were, on average, 0.33 U/ml; 0.13 U/ml and 0.25 U/ml, respectively in winter, thermoneutrality and summer.

Key words: Smart-Farming, Animal Welfare, Real Time, Environmental Control, Pigs.

1. Introduction

The intensification of production has generated some problems related to animal health and welfare in modern facilities. Pig farms, being a highly specialized animal husbandry, have some of these problems. On the other hand, with the population increase, a greater production of food is required, at increasingly reduced costs, where consumers demand the quality of the products. Alongside with product quality, consumers are increasingly concerned about animal welfare issues.

Due to the high demand for more products and higher quality, it becomes obvious that the verification and maintenance of animal welfare can not only be done by the employees of the farms. Early detection and real-time monitoring of normal behaviours (feed intake behaviour) and abnormal behaviour (aggressions) reduces animal production costs, limits the incidence of diseases and is capable of reducing mortality (Nasirahmadi et al., 2017a).

Pigs in intensive systems have to cope with long-term and intense short-term stressful stimuli that affect their welfare. High levels of stress and poor welfare have negatives effects in pig performance (Smulders et al., 2006). Throughout the stages of growth and maturity, one of the most important factors affecting welfare is the environment which animals are maintained. The environmental temperature has direct effects on pig behaviour (Nasirahmadi et al., 2015) and has a negative effect in their productivity (Banhazi et al., 2009; Vieira et al., 2010). When environmental temperature changes pigs adapt their behaviours to maintain body temperature (Nasirahmadi et al., 2017b). Feed intake and gain weight are also affect by the temperature (Vieira et al., 2010).

In order to measured animal welfare it is necessary to use a set of indicators (behavioural, physiological, productive and sanitary) capable of expressing the animals' adaptability to the environment provided. There is no a "gold standard" procedure to determine with accuracy the degree of animal welfare and the level of stress of an animal. Methodologies frequently used to quantify stress in animals include the direct behavioural observations or automated behaviour recognition video analysis (Ott et al., 2014; Nilsson et al., 2015) and biomarkers that can reflect the pathophysiological responses to stress (Ayala et al., 2012 and Escribano et al., 2015 cited by Martinez-Miró, 2016). Avoiding a threat, facing up to it or hiding from it can be described as normal behaviour, whereas stereotypes are considered as abnormal behaviours that can appear after a stress (Squires et al., 2003 cited by Martinez-Miro, 2016).

In addition we can measure the animal stress with α-amylase present in the saliva (Fuentes et al., 2011). Salivary alpha-amylase levels respond to physiological stressors. This it is measured in saliva and its activity is correlated with plasma catecholamine concentrations, being a marker of the sympathetic-adrenal-medullary axis activation (DeCaro, 2008; Nater et al., 2009). The use of saliva as sample for stress evaluation can be obtained by non-invasive procedures that do not produce additional stress or harm to the animals. In addition, saliva sampling procedures are very simple to obtain and can be taken by personnel with minimum training (Gutierrez et al., 2009 cited by Fuentes et al., 2011).

Another way to evaluate the animals' responses to the thermal environment is by observing the temperatures, such as body temperature (Vieira et al., 2010) and surface temperature. This measurement guides the determination of the balance between gain and heat loss of the body, which is often used as an adaptability index (Mota, 1997 cited by Vieira et al., 2010).

The aim of this study is to verify the adaptive evolution to different environmental conditions (winter, thermoneutrality and summer) in growing and fattening pigs through physiological, behavioural and productive indicators.

2. Materials and Methods

Animals, Housing and Equipment

Seven crossbred growing gilts were used for the present study. All animals were randomly selected from SIAS commercial farm in Santiago do Cacém and transfer to the experimental farm of Mitra in Évora. The gilts had a average body weight of 45±0.5 kg, they were housed in a room equipped with an environmental control system with area per animal of 1,5m^2.

At the entrance, all gilts were identified with an RFID ear tag. The animals were adapted for a period of 15 days with ad libitum food with a standard commercial diet with and have free access to water. During this period, the gilts were handle by our staff and trained to be accustomed to saliva sampling. During these days the environmental control system was set to thermoneutrality, the temperature was 18 ± 2ºC and relative humidity was 60%.

The room was equipped with sensors of temperature (T), relative humidity (RH) and wind speed (Ws). Cameras and microphones were also installed. The animals were fed with an individual automatic feed machine (schauer *compident MLP II*) equipped with a scale for the food and other for the animals. The machine was provided with an electronic identification system that was activated by the RFID ear tag. The feeding machine was connected to a computer to record and save the data (feed consumption and animal weight).

Experimental Design

The environmental control system was capable of simulate three different environmental conditions: winter (W) – cold stress, thermoneutrality (TN) and summer (S) – heat stress. The control system also allows to make a variation of the temperature and the humidity. We set up the control system for winter with T: 10 ± 2ºC, HR: 80%; thermoneutrality with T: 17 ± 2ºC, HR: 60% and in summer conditions we define T: 30 ± 2ºC, HR: 50%. The experimental period of each condition was 13d.

Samples

We measure surface temperature, body temperature and collect saliva. All the samples were collected 2 times by condition at 9 am. The first data collection was made 4d after the change of the conditions; the other one was made before the change for the next condition. Surface temperature (sT) was measure with an IV thermometer in the neck, this measure was taken very quickly, approximately 5s per animal. Body temperature (bT) was measure in rectal area with a digital thermometer, each measure take 1min. Saliva was collected using commercial salivette tubes with cotton. Each gilt was allowed to chew 2 a 3mints in the cotton. After that the samples were refrigerate. The tubes were centrifuged at 5000 rpm for 5 min. The analyses were made following the protocol by *Salimetrics salivary α-amylase kinetic enzyme assay kit*.

3. Results and Discussion

As expected, depending on the environmental condition, we observed a change in feed intake (FI) and in average daily gain (ADG) (Table 1).

Table 1. Mean values of feed intake and average daily gain (ADG), for the three environmental conditions.

Environmental condition	Feed Intake (kg.d^{-1})	ADG (kg.d^{-1})
W	2.70	0.611
TN	2.51	0.947
S	2.17	0.526

In summer conditions (heat stress) feed intake decreases (Pearce et al. 2013) and also the mean of average daily gain, these results are also reported (Collin et al., 2001; Banhazi et al., 2009; Kiefer et al., 2009). In W conditions we observed and increase in feed intake, as reported by Quiniou et al. (2000), although there was a decrease in average daily gain. These results are consistent with the reported by Li and Patience (2017) since the animals to increase the heat production consumed more food. Regarding body temperature, rectal temperature and surface temperature were measured, and the results obtained are shown in table 2.

Table 2. Mean temperatures of animals, body temperature and surface temperature, for the 3 environmental conditions.

Environmental condition	bT (ºC)	sT (ºC)
W	38.4	25.4
TN	38.3	29.1
S	39.4	34.0

Surface temperature measurement is a quick and practical method of verifying that animals are outside the comfort zone (Mostaço, 2014). This indicator is more variable and more influenced by the environment (Manno et al., 2009), as is observable in the results obtained in this test, where the sT have greater variation between the different simulated environmental conditions. Huynh et al. (2005); Manno et al. (2006) and Kiefer et al. (2009) observed that when the ambient temperature increases the surface temperature also increases.

Regarding the rectal temperature in pigs is, on average, 38.8ºC (Cunningham, 1993). The values obtained in this study fall within this temperature, however, there is a slight increase during the summer simulation. This increase was observed with increasing ambient temperature, this increase was also reported by Huynh et al. (2005) and Kiefer et al. (2009). The increase in body temperature, as a rule, means that the animal is storing heat, due to the failure of thermoregulation mechanisms (Ferreira, 2002, cited by Rodrigues, 2010). That is, when the ambient temperature rises above the capacity of physiological readjustment, the retained body heat is capable of altering the state of homeothermia, being an increase in the rectal temperature, which becomes more intense with the degree of deviation of the temperature of thermal comfort.

When the ambient temperature does not correspond to comfort levels, pigs present specific behavioral characteristics and are able to change their behavior to adapt to the environment that surrounds them (Quiniou et al., 2000). Indeed, temperature is the main parameter affecting pigs lying behavior (Nasirahmadi et al., 2015). These were the results observed by our team, with the animals gathering when the ambient temperature was below the thermoneutral temperature (winter situation), and the spacing when the ambient temperature was above the thermoneutral temperature (summer situation), which is in accordance with the bibliography consulted (Nasirahmadi et al., 2017a, b).

Figure 2. In S conditions (left) the gilts prefer to rest apart, without contact between them. In W conditions (right) the gilts choose to huddle.

Concerning to the α-amylase samples (table 3), we found that the values for α-amylase are greater in the W and in the S.

Table 3. Mean values for α-amylase activity.

Environmental condition	α-amylase (U/ml)
W	0.3252
TN	0.1382
S	0.2544

We didn't find any bibliography that relate thermal stress with α-amylase activity, however we found some studies that relate α-amylase activity with psychological stress and physical stress. These studies report that α-amylase increased with thermal stress (DeCaro, 2008; Nater et al., 2009; Fuentes et al., 2011) and these results agree with the results in our study.

4. Conclusions

With this study we can conclude that these welfare indicators can give us the information about the animal welfare. Although we collect some of the data manually, there is technologies that can gather and analyze the data, for example thermo cameras that gave the temperatures. Feed intake, ADG and sT changes with the environmental conditions. In bT changes only occurred in summer conditions, this may suggest that the animal had more difficulties in adapting to the hot temperatures. In relation to alpha amylase, the values increase with thermal stress, however further studies should be done in order to clarify α-amylase activity caused by thermal stress.

References

Banhazi, T. M., Aarnink, A., Thuy, H., Pedersen, S., Hartung, J., Mullan, B., Payne, H., and Berckmans, D. (2009). Review of the Consequences and Control of High Air Temperatures in Intensive Livestock Buildings. Australian Journal of Multi-Disciplinary Engineering, 7(1), 63–78.

Collin, A., van Milgen, J., Dubois, S., and Noblet, J. (2001). Effect of high temperature on feeding behaviour and heat production in group-housed young pigs. British Journal of Nutrition, 86, 63.

Cunningham, J. G. (1993). Tratado de Fisiologia Veterinária. Guanabara Koogan S.A.

DeCaro, J. A. (2008). Methodological considerations in the use of salivary alpha-amylase as a stress marker in field research. American Journal of Human Biology, 20, 617–619.

Deen, J. (2010). Pigs : Behavior and Welfare Assessment, 731–739.

Fuentes, M., Tecles, F., Gutiérrez, A., Otal, J., Martínez-Subiela, S., and Cerón, J. (2011). Validation of an automated method for salivary alpha-amylase measurements in pigs (Sus scrofa domesticus) and its application as a stress biomarker, 287, 282–287.

Huynh, T. T. T., Aarnink, J., Verstegen, M. W., Gerrits, W. J. J., Heetkamp, M. J. W., Kemp, B., and Canh, T. T. (2005). Effects of increasing temperatures on physiological changes in pigs at different relative humidities. Journal of Animal Science, (83), 1385–1396.

Kiefer, C., Meignen, B. C. G., Sanches, J. F., and Carrijo, A. S. (2009). Resposta de suínos em crescimento mantidos em diferentes temperaturas. Archivos de Zootecnia, 58(221), 55–64.

Li, Q., and Patience, J. F. (2017). Factors involved in the regulation of feed and energy intake of pigs. Animal Feed Science and Technology, 233, 22–33.

Manno, M. C., Oliveira, R. F. M. De, Donzele, J. L., Oliveira, W. P. De, Vaz, R. G. M. V., Silva, B. A. N., Saraiva, E. P. and Lima, K. R. de S. (2006). Efeitos da temperatura ambiente sobre o desempenho de suínos dos 30 ao 60 kg. Revista Brasileira de Zootecnia, 35(2), 471–477.

Martínez-Miró, S., Tecles, F., Ramón, M., Escribano, D., Hernández, F., Madrid, J., Orengo, J., Martínez-Subiela, S., Manteca, X. and Cerón, J.J. (2016). Causes, consequences and biomarkers of stress in swine: an update. BMC Veterinary Research. 12, 171.

Mostaço, G.M. (2014). Determinação da temperatura retal e frequência respiratória de suínos em fase de creche por meio da temperatura da superfície corporal em câmara climática. MS dissertation in Engenharia de Sistemas Agrícolas. Escola Superior de Agricultura "Luiz de Queiroz", University of São Paulo, Piracicaba, Brazil.

Nasirahmadi, A., Richter, U., Hensel, O., Edwards, S. and Sturm, B. (2015). Using machine vision for investigation of changes in pig group lying patterns. Computers and Electronics in Agriculture 119, 184-190.

Nasirahmadi, A., Edwards, S.A. and Sturm, B. (2017a). Implementation of machine vision for detecting behaviour of cattle and pigs. Livestock Science, 202, 25-38.

Nasirahmadi, A., Hensel, O., Edwards S.A. and Sturm, B. (2017b). A new approach for categorizing pig lying behaviour based on a Delaunay triangulation method. Animal, 11, 131–139

Nater, U. M., and Rohleder, N. (2009). Salivary alpha-amylase as a non-invasive biomarker for the sympathetic nervous system : Current state of research. Psychoneuroendocrinology, 34, 486–496.

Nilsson, M., Herlin, A. H., Ardö, H., Guzhva, O., Aström, K., and Bergsten, C. (2015). Development of automatic surveillance of animal behaviour and welfare using image analysis and machine learned segmentation technique. Animal, 1–7.

Ott, S., Moons, C. P. H., Kashiha, M. A., Bahr, C., Tuyttens, F. A. M., Berckmans, D., and Niewold, T. A. (2014). Automated video analysis of pig activity at pen level highly correlates to human observations of behavioural activities. Livestock Science, 160, 132–137.

Pearce, S., Gabler, N., Ross, J. W., Escobar, J., Patience, J. F., Rhoads, R. P., and Baumgard, L. H. (2013). The effects of heat stress and plane of nutrition on metabolism in growing pigs. Journal of Animal Science, 91, 2108–2118.

Quiniou, N., Dubois, S., and Noblet, J. (2000). Voluntary feed intake and feeding behaviour of group-housed growing pigs are affected by ambient temperature and body. Livestock Production Science, 63, 245–253.

Rodrigues, N. E. B., Zangeronimo, M. G., and Fialho, E. T. (2010). Adaptações fisiológicas de suínos sob stress térmico. Revista Eletrónica Nutritime, 7(110), 1197–1211.

Smulders, D., Verbeke, G., Mormède, P., and Geers, R. (2006). Validation of a behavioral observation tool to assess pig welfare. Physiology and Behavior, 89, 438–447.

Vieira, R. de F. N., Silva, K. O., Mello, S. P., and Martins, J. R. (2010). Índices de conforto na avaliação do bem estar animal de matrizes suínas em diferentes sistemas de criação. Nucleus Animalium, 2(1), 1–8.