THE INFLUENCE OF A CONTROLLED MICROCLIMATE ON THE PRODUCTION PERFORMANCE IN WEANED PIGS

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Abstract

The study deals with the influence of external environmental factors on pig production. It is safe to assume that with common management and corresponding quality of buildings, technology and other inputs, the microclimate is an important factor in breeding efficiency and health in pigs. Correct parameter setting of the living environment of stables, based on the temperature curves and relative humidity (RH), causes temperature-humidity animal welfare, which significantly affects the production yield.

It has been shown that controlled stable microclimate, according to the temperature and RH, significantly increases the live weight ($P \leq 0.05$) in growers, as well as their growth intensity ($P \leq 0.01$). It was also demonstrated that the selected production traits in pigs of both sections (with controlled and uncontrolled microclimate) are influenced by the current season.

Key Words: Pig, weaner, growth production, ventilation.

Today the livestock industry employs a wide range of electronic systems implemented in the control of breeding. It is becoming apparent that it is possible to reduce the cost of pig breeding by selecting new pig genotypes (Novak, 1993, Stupka et al, 2006), increasing production parameters via the use of higher quality feed mixtures and also by the application of new feeding techniques (Kodes, et al., 2001). Beyond this framework of possibilities there is another way of reducing the economical cost and this is represented by creating suitable environmental microclimatic conditions. These should focus primarily on the temperature-humidity conditions (Pfizer, 2005). According to Novak et al. (2001), these conditions closely relate to the hygiene of stables, which can be described as a function of health (Close, 1977) and therefore a function of efficiency and quality of the final product (Odehnalova, 2006).

However the environmental optimization shows significant reserves. This can be due to the combination of environmental factors, which has a completely different effect than the individual factors acting alone (Oberreuter, 2005). The most significant here is the interaction of different temperatures, air velocity, relative humidity, gas content, climate, etc. (Líkař, 2005). A certain role is also played by the specifics of location of the farms and stables (Storlie, 2006).

The main microclimate tool is the relationship between humidity and temperature (Granier, 1998). This relationship is expressed via Mollier diagram, which shows how the temperature and humidity (as well as the wet bulb temperature) change during evaporation (Classens, 2006). A very commonly seen practical error in breeding is the use of a regular thermometer (without the option of measuring relative humidity as well) in order to determine the current temperatures inside the stables. That is why foreign literature often cites the expression „wet bulb temperature“, which reflects the influence of RH on subjectively perceived temperature. Therefore, according to Morrison et al. (2005), it is important to assess the air temperature inside the stables with the use of dry air temperature (TDB = dry bulb temperature) and wet temperature as well (TWB = wet bulb temperature). This statement is confirmed by the fact that the thermal comfort zone of pigs is very narrow (ACME, 1994). Deviations from the lower/upper critical temperature values (UCT/ULT) lead to the production of heat in order to maintain the comfort zone (Pitcher, 2000, Oberreuter, 2005).

More important than the temperature itself is the combined effect of temperature and RH. Relative humidity distorts the effect of temperature on a given animal. Under conditions with higher humidity the pigs subjectively perceive higher temperature than the indicated dry-bulb temperature. That means that the animals approach the level of temperature stress at much higher speed, in spite of the fact that the indicated dry-bulb temperature can be subjectively within normal limits (Novak et al, 1998). On the other hand with decreasing humidity the pigs enter the zone of stress even if the temperature inside the stables corresponds to the requirements established by the dry-bulb temperature. As it is evident, the dry-bulb temperature holds a very small informative value (Bottcher, 2001).

Matarial and Methods

The aim of this study was to quantify the influence of temperature-humidity microclimate parameters on pig stalls (i.e. to compare the results of sections with controlled and uncontrolled microclimate at different times of the year, in the pre-fattening pigs).

For this purpose the values of individual microclimate components in the stables were measured and compared. For the needs of this study, stables for pre-fattening pigs were chosen. The stables were divided into sections, each one containing 200 animals with live weight of 7-30kg. The study monitored two of these sections. The microclimate in the control section was controlled only by the temperature, while the microclimate in the experimental section was controlled by the temperature with relative humidity limited to 65-75%. The temperature curve was set to the levels of temperature indicated by the "wet bulb" according to the Mollier curve and corresponding to 65% RH (i.e. to the level expected from the values of THI = temperature-humidity index, set by the values of temperature curve and relative humidity 65%). It is therefore apparent that the temperature curve was set to the level of expected subjective temperature, determined with the inclusion of the relative humidity effect. All animals were weighed at weaning and afterwards their weight was regularly measured. The next measurements were taken when penned (LW1) and then 14 (LW14), 28 (LW28), 42 (LW42) and 56 (LW56) days after their stay in the respective sections. The values obtained were used in order to calculate the average daily gain (ADG1, ADG14, ADG28, ADG42, ADG56).

The monitoring was carried out during three seasons (winter, spring, autumn). The average temperatures in the winter, spring and summer periods during the experiment reached 5.3, 18.6 and 21.4^{o}C (Czech Meteorological Institute data) respectively. Out of the microclimate indicators of both sections, the following were monitored:

- SI1 - temperature according to the standard temperature curve for pre-fattening pigs,
- SI2-adjusted temperature with respect to RH,
- T-actual temperature of the stable,
- Tcalk-calculated temperature according to THI (T_{THI}), meaning modified TWB,
- RV-relative humidity,
- P-pressure,
- NH_3-ammonia concentration.

The results were evaluated with the use of statistical methods, using the SAS ® 6.4 Propriety Software Release program, procedures MEANS, UNIVARIATE, GLM, CORR and REG. For the categorical variables, the frequency analysis was performed in order to detect potential invalid values. For continuous variables the analysis of extreme values was performed and then a multiple hierarchical model was constructed in order to detect the influence of individual factors. The model is as follows:

$\boldsymbol{Y = \mu + P_i + S_j + C_k + K_l + e_{ijkl}}$, where

Y - values of monitored parameters,
μ - population average,
P_i - the effect of season (winter, spring, summer),
S_j - the effect of microclimate control (standard N, experimental R),
.
C_k - the effect of pen (1-8),
K_l - the effect orf pen´s placement (right, left side),
e_{ijkl} - random error

Results and Discussion

The stable microclimate characteristics (with respect to the individual seasons) are shown in Table 1. The initial required temperature in the standard section during the winter was 30°C. This temperature was gradually lowered by 0,5°C in order to reach temperature of 21°C after 54 days. The values of required temperature curve and the values of S11 and S12 are identical. The temperature in the controlled section was adjusted so that the level of T_{THI} values is equal to the temperature shown on the standard temperature curve by adding the THI difference (corresponding to RH maximum). The difference was fixed at +5°C. The T_{THI} values were derived from the TWB and related to the expected RH 65-75%. The actual T_{THI} and TWB were continuously calculated according to the actual T_i and RH in both sections (T_{CALK}).

The average temperature calculated according to the originally considered temperature curves in both sections was 25.6°C. The average temperature of the values set on the standard computer was 25.6°C in the standard section and 30.6°C in the experimental section. The average temperature over the course of the experiment was indeed 24.6°C (i.e. TDIF was 1°C under the curve) in the standard section and 29.7°C in the experimental section (0.9°C below the curve in average THI values).

The actual temperature, approaching the subjectively perceived temperature, is called T_{CALC}. In the standard section, the average temperature value was 18.7^{o}C, while in the experimental section the temperature was much more favorable (25°C - which is only about 0.6 ^{o}C below the set temperature curve).

Although the ventilation systems experience problems with the minimum ventilation settings during winter, the measured RH in the standard and experimental sections was 55.8, and 64.9%, respectively. That means that the results for this season reached a very satisfying level. The negative pressure values (13.9 Pa) correspond to the correct pressure ratio settings and the width of the stable. Also the levels of ammonia concentration were very satisfactory.

The requirements for gradual reduction of the temperature during the spring and summer remained the same as the ones established for the winter season, therefore the S11 and S12 are practically identical. The actual achieved temperatures were 26.5 (26.9 ^{o}C) in the standard section and 29.0 (30.4 ^{o}C) in the experimental section. Concerning the subjectively perceived temperature, T_{CALC}, in the standard section this temperature reached the values of 5.5 (2 ^{o}C) below the desired temperature. The higher temperature differences with regards to the RH and THI in the experimental section can be considered more favourable.

The measured RH in the standard section reached 58.1 (71%) and in the experimental section the measured values reached 55.3 (60.6 %). The negative pressure in the sections (14 Pa) and reached ammonia levels both support the right adjustment of pressure conditions inside the stables sections.

Table 2 shows the levels of the selected fattening performance indicators with respect to seasons and section.

As it is evident from the results (LW1), in winter the standard section was used to fatten the initially heavier pigs ($P \leq 0.05$). However, their peers located in the experimental section demonstrated significantly higher growth intensity (by 4.4% - $P \leq 0.05$).

It is also evident from Table 2 that, for the same initial weight, in spring the animals located in the controlled section reached significantly ($P \leq 0.05$) higher growth intensity. This fact is documented by higher average live weights (LW 14,28,56) at different pre-fattening stages, but also by the final average daily gain difference (11.2% - $P \leq 0.01$).

Concerning the summer season it can be stated that the influence of microclimate control on the growth of both sections was not demonstrated. However, from the average daily gain values, it can be concluded that higher temperatures not only reduce the animals' growth, but partially eliminate the influence of the air RH in the stables, as documented by PigSite (2009). Similar experiments were also carried out by Collin et al. (2001).

Table 1. The stable microclimate characteristics with respect to the seasons (n=7800)

Item	Standard section						Experimental section					
	winter		spring		summer		winter		spring		summer	
	µ	SD	µ	SD	µ	SD	µ	SD	µ	SD	µ	SD
SI1 (°C)	25.6	2.6	26.2	2.3	25.6	2.6	25.6	2.6	26.2	2.3	25.6	2.6
SI2 (°C)	25.6	2.6	26.2	2.3	25.6	2.6	30.6	2.6	31.2	2.3	30.6	2.6
T (°C)	24.6	2.8	26.5	2.3	26.9	2.8	29.7	2.3	29.0	2.7	30.4	2.6
Tdif (°C)	-1.0	1.7	0.4	1.2	1.3	2.5	-0.9	1.3	-2.2	1.9	-0.2	1.0
Tcalk (°C)	18.7	3.5	20.7	2.4	23.6	3.5	25.0	2.2	22.2	2.5	24.6	2.7
RV (%)	55.8	10.9	58.1	6.6	71.0	16.8	64.9	2.7	55.3	5.8	60.6	7.4
P (Pa)	13.9	0.3	14.1	0.2	14.0	0.1	13.9	0.3	14.0	0.2	13.9	0.1
NH_3(ppm)	12.2	1.7	11.1	1.4	9.6	0.7	12.0	1.4	11.7	1.0	11.3	1.2

Table 2. The selected fattening performance indicators with respect to the stable microclimate and year seasons (n=7800)

Item	winter					spring					summer				
	SS		PS		P	SS		PS		P	SS		PS		P
	µ	SD	µ	SD		µ	SD	µ	SD		µ	SD	µ	SD	
LW1	7.79	0.16	7.53	0.21	*	7.35	0.56	7.32	0.14	N	6.88	0.09	6.75	0.30	N
LW14	12.66	0.24	12.68	0.30	N	8.53	1.15	9.61	0.41	*	11.76	0.21	11.71	0.24	N
LW28	17.76	0.39	17.84	0.31	N	11.24	1.75	12.83	0.48	*	17.00	0.14	17.28	0.43	N
LW42	23.99	0.55	24.28	0.75	N	23.71	2.73	25.61	0.60	N	23.39	0.43	23.79	0.83	N
LW56	30.00	0.83	30.67	0.78	N	27.94	2.48	30.35	0.59	*	29.67	0.87	30.00	0.82	N
ADG1-14	348	21	369	25	N	147	129	847	106	N	349	14	354	21	N
ADG15-28	364	27	368	30	N	301	84	358	55	N	374	20	398	33	N
ADG29-42	445	42	460	38	N	499	44	511	17	N	457	26	465	42	N
ADG43-56	463	38	692	22	N	705	91	789	89	N	448	58	443	20	N
ADG1-56	404	16	421	15	*	444	27	500	32	**	407	15	415	13	N

** - differences between the averages are statistically significant (P<0,01),
* - differences between the averages are statistically significant (P<0,05),
NS - differences insignificant

Conclussion

Based on the results of our study it can be stated that a significant positive effect of controlled microclimate (controlled by the temperature and RH) on the live weight and growth intensity of weaned pigs was demonstrated. The study also confirmed the effect of season on selected monitored production traits of pigs in both the control and experimental sections.

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