

Air sterilization for swine

Evaluation of zootechnic indexes at the maternity stage of a swine commercial farm using air sterilizer

F. R. M. Soto^{*†}, E. R. Vuaden[‡], C. P. Coelho[†], D. Matias⁺, N. R. Benites[†], L. Otani[‡], P. A. Melville[†], S. A. Vasconcellos[†] e S. S. Azevedo[#]

†- University of São Paulo, São Paulo, Brazil, ‡-M. Cassab, Animal Nutrition, São Paulo, Brazil, +-Air Free Agro of Brazil, São Paulo, Brazil, # Academic Unit of Veterinary Medicine of Federal University of Campina Grande, Campus of Patos, Paraíba, Brazil.

Correspondence to*
Francisco Rafael Martins Soto
Caixa Postal 34 – Ibiúna- SP- Brazil
CEP- 18150-000
chicosoto34@gmail.com
Phone fax 00 55 15 3294-2223

ABSTRACT

This experiment evaluated the zootecnic performance and its cost benefit relation for the maternity stage of a swine farm using air sterilizer. Two groups of 16 sows each were used: a treated one with air sterilizer and a control group without treatment. It was daily observed the occurrence of mortality in piglets, diarrhea, food consumption, sows and piglets' behavior and odor of the maternity room. Piglets' weight was taken individually and for each sow group at the moment of weaning. Growing of Gram negative and positive bacteria and fungi were measured using seed agar plates exposed to maternity environment. Electric power consumption of the equipments for treated group was evaluated using an electric meter in Kilowatthours. To analyze quantitative parameters between groups, a normality test was performed; for parameters with normal distribution it was used the *t*-test and for those with non-normal distribution the U test was used. For all analysis of zootecnic performance significance level was 5%. Control group mortality rate was 12.71% and for treated group it was 6.96%. Diarrhea occurred in 22 piglets from control group against six for piglets of treated group ($P = 0.0001$). Control group mean weigh at weaning was 5.97 Kg against 6.70 Kg for treated group ($P < 0.0001$). For control group total score for sows' behavior was 111 points, against 85 for treated sows ($P < 0.0001$). Considering piglets behavior, total score for control group was 84 points against 75 for treated group ($P = 0.463$). Control group points for the parameter odor of the room were 154 against 102 for treated group ($P < 0.0001$). Total food consumption for control group sows was 1912.5 Kg and for treated group sows it was 2038.2 Kg. No significant difference was observed in relation to bacteria growth in plates when compared treated and control groups. Electric power cost was

US\$ 0.238 each equipment. The use of the physical method for air sterilization at the maternity contributed to increase zootecnic performance of the animals at this stage.

Key words: swine, air sterilizer, maternity, microorganisms.

INTRODUCTION

The main objective of swine industry is to maximize meat production in tons per sow per year. Among the problems faced on swine exploitation, infectious diseases are considered important and cause considerable losses in a swine commercial farm (Wentz et al., 2001). Maternity is the stage where losses can be bigger with the occurrence of enteric or respiratory infectious diseases that affect piglets. Most important bacterial microorganisms responsible for mortality of weaned piglets or their rejection with reduction of weigh gain and that may be present as suspension at swine facilities are: *Streptococcus suis*, *Haemophilus parasuis*, *Pasteurella multocida*, *Mycoplasma hyopneumoniae* and *Escherichia coli* (Sobestiansky et al., 1999).

The most important viral microorganisms that may contribute to increase piglets' mortality at the maternity are: rotavirus, swine circovirus and reproductive and respiratory swine syndrome (Sobestiansky et al., 1999).

Searching solutions to increase productivity levels, environmental interventions of swine facilities are indicated. Studies have been made using chemical methods constituted by disinfectants applied through aspersion, nebulization or pulverization at swine facilities to control, reduce or eliminate pathogenic microorganisms present in the air (Karadzhev et al., 1986; Bilic et al., 2000). There is also need to study physical methods of air sterilization for this problem.

The objective of this experiment was to evaluate zootecnic performance mainly in relation to mortality rate and gain of weigh for piglets at weaning phase, using a physical disinfection and sterilization method of the maternity room air, as well as its cost benefit relation.

MATERIAL AND METHODS

The experiment was developed at a commercial swine farm from Ibiúna Municipality, São Paulo, Brazil, with 200 sows. Females were cross bred from Landrace and Large White with similar genetic and history of parturition (between 1st and 5th parturition). Animals were kept at the maternity with three meters foot high and farrowing crates with slotted floor. Food for sows was composed of ground corn, soy bran, raw pasta, defatted corn germen and vitamins and mineral supplementation. Nutritional levels were 18.43% crude protein, 4.27% ethereal extract, 3.34% crude fiber, metabolic energy of 3300 Kcal and 1.00% lysine. Mean quantity of food was 3.00 Kg per sow until five days after parturition. After this period, food was given “*ad libitum*” in individual feeders. Water was supplied in suckling type drinker placed beside feeder.

Two groups of a total 32 sows were separated into four maternity rooms, with eight sows each. Two rooms with 16 sows and without air sterilizer equipment belonged to control group and sows from the treated group were kept at the other two rooms, containing one air sterilizer equipment for each farrowing crate during 24 hours at one meter high from the floor. The equipment used was made of ceramics with an internal electric resistance of 220 volts and it was protected with plastic, which allowed air flow in it. Air sterilizer dimensions were 13 cm diameter and 34 cm high. Experiment was

developed during 28 days, comprehending from sows' placement at farrowing crate one week after birth and 21 days until weaning.

Using control files during experimental period, the following parameters were evaluated:

- a) Mortality of piglets, its cause and age of animals at death;
- b) Occurrence of diarrhea using the method described by Mores (1999);
- c) Daily food consumption for sows;
- d) Behavior of piglets and sows. Adopted score was from one to three as follow: one – calm level, two – medium level and three – agitated level;
- e) Odor of the rooms. Adopted score was from one to three as follow: one – without odor, two – medium level and three – high odor level;

To define the scores of daily total values for piglets and sows and odor of the rooms, evaluation took three months during morning, afternoon and evening by visual observation of animals and sensorial smelling.

Considering the parameters minimum, mean and maximum temperature of external environment and of maternity room and air humidity, two daily air evaluations were made during morning and afternoon (table 1). Maternity temperature control for both experimental and control groups was made using curtains, totalizing 21 procedures of opening and 21 closures during evaluation period (table 1).

Microenvironment temperature for piglets was controlled using electric warmers, which were turned on for 16.2 hours and they were turned off for 7.8 hours to ensure temperature comfort for animals.

Piglets were weighted for each sow lot at birth and at weaning phase, the last day of experiment, in order to evaluate daily gain of weight.

Plates containing blood sheep agar media culture (5%), MacConkey agar, agar for standard counting and Sabouraud dextrose agar with addition of chloranfenicol, were exposed in duplicate at maternity environment for ten minutes and then they were close and shipped under refrigeration to microbiology laboratory. Plates were exposed in nine different days, considering days 09/20, 09/28, 01/10, 10/08 and 10/11/2007 for treated group and 10/16, 10/19, 10/23 and 10/31/2007 for control group.

Plates containing blood sheep agar media culture (5%), MacConkey agar, agar for standard counting were incubated at 37°C for 24-48 hours. Plates containing Sabouraud dextrose agar were incubated at 25°C for seven days.

After incubation periods plates were submitted to forming unit counting (FUC) and for MacConkey agar plates it was also made differential counting for lactose positive and negative bacteria, filamentous fungi and yeast.

It was measured electric power consumption of treated group and its cost benefit relation using an electric meter in KW/hour.

All zootechnic indexes for maternity were obtained through data stored at specific software of the farm, named Suinsoft version 3.0.7.

To compare quantitative variable between groups (mean weight at birth, mean weight at weaning phase and mean daily score – sows behavior, mean daily score – piglets behavior and mean daily score - odor of the rooms), the Kolmogorov-Smirnov normality test was first adopted. The *t*-test was adopted for variable with normal distribution; for those variables with non-normal distribution the Mann-Whitney U test was used (Zar, 1999). In order to compare proportions of diarrhea occurrence and mortality rate, the chi-square test was used. For all zootechnic performance analysis the significance level adopted was 5% and the statistical program adopted was the *SPSS for*

Windows version 13.0. Media culture statistical analyses were made using the Mann-Whitney and T tests, with the software GraphPad InStat 3- Copyright InStat (1998).

RESULTS

Results of number of deaths and occurrence of diarrhea in piglets until weaning phase are presented on table 2. Mortality rate for control group was 12.71% and for treated group it was 6.96% with a reduction of 45.23%. Despite this result, there was no statistical difference for this parameter with P value equal to 0.159. Major causes of death for control group were crushing of piglets, unspecific diarrhea and malnutrition due to low weight at birth and occurring mainly from the first to the fifth days. Causes of death for treated group were the same of control group except for unspecific diarrheas. The number of piglets suffering from diarrhea at control group was 22 animals or 18.64% from the total and for treated group six animals or 3.79% were affected and this parameter was considered statistically significant with a P value equal to 0.0001.

Table 3 shows results obtained for parameter total weigh at birth, weaning and cumulative gain of weigh. Mean weigh at weaning for control group was 5.97 Kg against 6.70 Kg for treated group, with an improvement of 10.89% for this parameter and with statistical significance from groups with P value < 0.0001.

Table 4 shows results of parameters evaluated in a period of 28 days and related to sows and piglets' behavior and odor of the rooms. Sows control group behavior total score was 111 points, against 85, for treated group, improving 23.43% for this parameter and statistical difference of P < 0.0001. Considering piglets' behavior, total score for control group was 84 points against 75 for treated group, improving 10.71%, but no statistical

difference was found, with a P value equal to 0.463. For the parameter odor of the room, total value of control group rooms was 154 points against 102 for treated group, improving 33.76% and a statistical difference with P value < 0.0001.

Considering food consumption by control group sows, total amount was 1912.5 Kg with daily mean of 4.26 Kg per sow. Treated group total amount of food consumption was 2038.2 Kg with daily mean of 4.54 Kg per sow. There was higher food consumption for treated group of 125.7 Kg, which represents an increase of 6.16% for this item.

For bacterial growing plates results and considering all five samples for treated group, median counting of F.C.U. for Gram positive bacteria was 287 (277 to 295)/10 minutes of environmental exposure. Median counting of F.C.U. for Gram negative bacteria was 13 (5 to 23)/10 minutes of environmental exposure. Median counting of F.C.U. for lactose positive bacteria was three (1 to 5)/10 minutes of environmental exposure. Median counting of F.C.U. for lactose negative bacteria was 10 (4 to 18)/10 minutes of environmental exposure. Median counting of F.C.U. for total fungi was 41 (10 to 69)/10 minutes of environmental exposure. Median counting of F.C.U. for filamentous fungi was 17 (3 to 42)/10 minutes of environmental exposure. Median counting of F.C.U. for yeast was 13 (5 to 35)/10 minutes of environmental exposure.

Considering all four samples of control group, F.C.U. median counting for Gram positive bacteria was 283 (254 to 297)/10 minutes of environmental exposure. Median counting of F.C.U. for Gram negative bacteria was 17 (3 to 46)/10 minutes of environmental exposure. Median counting of F.C.U. for lactose positive bacteria was 6 (1 to 14)/10 minutes of environmental exposure. Median counting of F.C.U. for lactose negative bacteria was 11 (2 to 32)/10 minutes of environmental exposure. Median counting of F.C.U. for total fungi was 38 (27 to 59)/10 minutes of environmental exposure. Median counting of F.C.U. for filamentous fungi was 15 (2 to 34)/10 minutes

of environmental exposure. Median counting of F.C.U. for yeast was 23 (17 to 31)/10 minutes of environmental exposure.

No significant statistical differences were observed when compared results of treated and control groups.

Each air sterilizer equipment consumed 2 Kilowatts of electric energy in the period of 24 hours, representing a daily cost of US\$ 0.238. All twenty equipment had a daily cost of US\$ 4.76 and a total of US\$ 133.28 during 28 days of experiment.

DISCUSSION

Researches evaluating air sterilizers to control, reduce or eliminate the presence of pathogens are common for human environment, mainly for food industry (Fan et al., 2007), hospital surgical centers, odontologic clinics and pharmaceuticals industry (Scherwing et al., 2007; Walker, 2007; Weiner and Kilgore, 2007). However there is a lack of research of this theme for animal intensive raising, mainly swine meat. Although no significant statistical differences were observed for bacteria media growing results when compared treated and control groups for the experiment conditions, the results obtained when using air sterilizer at maternity room were favorable. Mortality rate for control group was 12.71% and for treated group it was 6.96%, with a reduction of 45.23% for this parameter (table 2). These results are similar to those of Vieira (2007), in a swine herd of Portugal where he observed a reduction of 56% for piglets' mortality rate at the maternity using air sterilizers. Efforts to reduce piglets' mortality rate at maternity phase are of major importance, because this is a critical period of animal life where most of the losses occurs due to infectious diarrhea in the first days of life (Ngeleka et al., 2003). Death of piglets due to crushing, which primary cause may be

organic weakness caused by infectious diarrhea was reported by Koketsu et al. (2006). There were six piglets from treated group with diarrhea or 3.79% of the total, against 22 animals or 18.64% of total for control group ($P = 0.0001$). Mannion et al. (2007) reduced the presence of bacteria in suspension which were causative agent of diarrhea at swine herds from Ireland using chemical methods. The occurrence of diarrhea in piglets at the maternity stage has a decisive influence at mortality rate, gain of weigh and number of rejected animals (Ngeleka et al.; 2003). These results were corroborated with higher gain of weigh for piglets from treated group, 730.2 Kg and 6.7Kg of weigh at weaning, when compared to control group 437.7 Kg of cumulative gain of weigh and 5.97 Kg of mean weigh at weaning with an improvement of 10.89% for this parameter ($P < 0.0001$). Similar results were obtained by Vieira (2007), with an increase of 15.7% for piglets' daily gain of weigh at maternity stage using air sterilizer in swine facilities. Considering the totalized parameters of sows and piglets' behavior and odor of the rooms for treated against control group, these were satisfactory, with sows and piglets of treated group calmer than those from control group and the odor of the room was also reduced (table 4). Efforts to improve maternity environment facing improvement of zootechnic results are fundamental (Aarnink et al., 2006), because sows in healthy environment kill less piglets due to crushing, which is one of the major cause of mortality at maternity during piglets first days of life. Total food consumed by treated group sows was 2038.2 Kg with daily mean of 4.54 Kg per sow. There was more consumption on treated group with 125.7 Kg, representing an increase of 6.16% for this item. One of the major challenges for technified swine herds is to increase food consumption at maternity stage (Peng et al., 2007), since that sows which consume more food, have more milk and their piglets are heavier at weaning.

Regarding air sterilization cost benefit relation, there was economic gain using the equipment. If it is considered a herd of 200 sows, model of this experiment, with one equipment for each farrowing crate, 42 on total and mean birth of 450 piglets each month, estimated cost to maintain the equipment on during 24 hours would be US\$ 279.88 each month. The use of air sterilizer reduced in 45.23% mortality rate of piglets, avoiding death of approximately 28 animals and weaned piglets mean weight were 700 grams heavier. Maternity mortality reduction associated to piglets' weigh allows the increase in kilograms of meat produced per sow each year, converted in tons. Heavier animals at weaning will have better performance at following stages, with reduction of mean age for slaughter which confers more earning for swine exploitation.

IMPLICATION

Considering the conditions where the experiment was made, the use of a physical method of air sterilization at the maternity stage has contributed to improve zootecnic performance of animals mainly in relation to reduction of mortality rate, unspecific diarrheas, increase of weaned piglets gain of weight and better environmental quality of a commercial swine farm, with a favorable cost benefit relation.

REFERENCES

- Aarnink, A. J. A., M. J. W. Schrama, J. Heetkamp, and T. T. T. Stefanowska. 2006. Temperature and body weight affect fouling of pig pens. *J. Anim. Sci.* 84:2224-2231.
- Bilić, V., B. Habrun, I. Barac, and A. Humski. 2000. Distribution of airborne bacteria in swine housing facilities and their immediate environment. *Arh. Hig. Rada. Toksikol.* 51(2):199-205.

Fan, X., W. F. Fett, and B. W. Mitchell. 2007. Effect of negative air ions on *Escherichia coli* ATCC 25922 inoculated onto mung bean seed and apple fruit. *J. Food. Prot.* 70(1): 204-208.

GraphPad InStat 3, Copyright InStat, 1998.

Karadzhev, S., S. Kesiakova, and M. Pavlov. 1986. Prophylactic disinfection of the housing for suckling sows under commercial swine-raising conditions. *Vet. Med. Nauki.* 23(2):53-58.

Koketsu, Y., S. Takenobu, and R. Nakamura. 2006. Preweaning mortality risks and recorded causes of death associated with production factors in swine breeding herds in Japan. *J. Vet. Med. Sci.* 68(28):821-827.

Mannion, C., F. C. Leonard, P. B. Lynch and J. Egan. 2007. Efficacy of cleaning and disinfection on pig farms in Ireland. *J. Vet. Rec.* 161(11): 371-375.

Mores N. 1999. Diarréia pós desmame em leitões. Page 101-115 in Mini Simpósio do Colégio Brasileiro de Nutrição Animal, Belo Horizonte, Minas Gerais, Brasil.

Ngeleka, M., J. Pritchard, G. Appleyard, D. M. Middleton, and Fairbrother, J. M. 2003. Isolation and association of *Escherichia coli* AIDA-I/STb, rather than EAST1 pathotype, with diarrhea in piglets and antibiotic sensitivity of isolates *J. Vet. Diag. Invest.* 15(3):242-252

Peng, J. J., S. A. Somes, and D. W. Rozeboom. 2007. Effect of system of feeding and watering on performance of lactating sows. *J. Anim. Sci.* 85:853-860.

Scherwing, C., F. Golin, O. Guenec, K. Pflang, G. Dalmaso, M. Bini, and F. Andone. 2007. Continuous microbiological air monitoring for aseptic filling lines. *J. Pharm. Sci. Technol.* 61 (2): 102-9.

Sobestiansky, J., D. Barcellos, N. Mores, L. F. Carvalho and S. Oliveira. 1999. *Clínica e Patologia Suína*. 2 ed. Goiânia: Universidade Federal de Goiás.

Suinsoft - Sistemas para suinocultura, versão 3.0.7.

Vieira, R. P. 2007. A influência de tratamento de ar em maternidades de suínos de alta produção. *Airfree. Agr Manual.* 1: 1-5.

Walker, J. T. 2007. Use of benchtop steam sterilisers. *Br. Dent. J.* 203 (8): 468-469.

Weiner, B. K, and W. B. Kilgore. 2007. Bacterial shedding in common spine surgical procedures: headlamp/loupes and the operative microscope. *Spine.* 32 (8): 918-920.

Wentz, I., F. P. Bortolozzo, and G. Brandt. 2001. Hipertermia during estrus may influence the reproductive performance of female pigs. *Cienc. Rur.* 31, (4):651-656.

Zar, J. H. 1999. *Biostatistical analysis*. 4. ed. Upper Saddle River. Prentice Hall.

Table 1-Mean external environment temperature of maternity ($^{\circ}\text{C}$) and humidity in percentage (%) defined as current, maximum and minimum, according to the evaluation period (morning and afternoon) obtained during experimental period.

Parameter	Period					
	Current	Morning		Current	Afternoon	
	mean	Maximum	Minimum	mean	Maximum	Minimum
	mean	mean	mean	mean	mean	mean
Mean external environment temperature ($T^{\circ}\text{C}$)	16.81	23.14	12.39	21.60	28.42	15.03
Mean environment temperature of maternity ($T^{\circ}\text{C}$)	19.53	24.14	17.42	23.00	28.20	17.96
Mean air humidity of maternity (%)	67.1	68.00	54.96	54.80	66.1	44.10

Table 2- Results of the parameters number of deaths and occurrence of diarrhea in piglets until the weaning phase (21 dias) and their respective percentages (%) for treated group (with air sterilizer) and control (without air sterilizer) at the maternity of a commercial swine farm.

Parameter	Control group	Treated group	P value
Total number of newborns	118	158	-
Number of death	15	11	-
Mortality rate (%)	12.71%	6.96%	0.159
Number of piglets with diarrhea	22	06	-
Diarrhea occurrence rate (%)	18.64%	3.79%	0.0001

Table 3- Results for parameters total weigh at birth, at weaning (21 days), their respective means and cumulative gain of weigh in kilograms (kg) for treated group (with air sterilizer) and control (without air sterilizer) at the maternity of a commercial swine farm.

Parameter	Control group (Kg)	Treated group (Kg)	P value
Total weigh at birth	178.1	254.8	-
Mean weigh at birth	1.51	1.61	0.068
Total weigh at weaning	615.8	985.0	-
Mean weigh at weaning	5.97	6.70	< 0.0001
Cumulative gain of weigh	437.7	730.2	-

Table 4- Results for the parameters defined in score* and totalized in a period of 28 days for sows and piglets behavior, odor of the rooms and their respective means for treated group (with air sterilizer) and control (without air sterilizer) at the maternity of a commercial swine farm.

Parameter	Control group	Treated group	P value
Total score – sows behavior	111	85	-
Mean daily score- sows behavior	1.32	1.01	< 0.0001
Total score – piglets behavior	84	75	-
Mean daily score- piglets behavior	1.12	1.04	0.463
Total score - odor of the rooms	154	102	-
Mean daily score - odor of the rooms	1.83	1.21	< 0.0001

* Score for sows and piglets behavior: 1- calm, 2- average, 3- agitated

* Score for odor of the rooms: 1- low, 2- average, 3- high