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How do seasons and different combinations between on-farm fasting intervals and lairage period affect pigs' welfare, carcass and pork quality traits?

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Abstract: The objectives of this study were to study the effects and interactions of different combinations of on-farm fasting intervals and lairage period at different climates on blood stress parameters, carcass and meat quality in pigs. A total of 960 finishing pigs from eight farms was split into 12 treatments during two seasons used (5 pigs/12 treatments/2 seasons/8 repetitions or farm). Treatments consisted in a combination of four different on-farm feed withdrawal periods (8, 12, 16, 20 h) with three different lairage periods (1, 3, 6 h). Cortisol and lactate from 960 animals were collected in the sticking wound blood. All stomachs were weighed full and emptied and their content were collected and subjectively scored according to the amount of feed and water. In the chiller, carcass lesions were assessed on each left carcass side and classified by visual assessment of shape and size. Meat quality traits, such as pH, colour and drip loss, were assessed in 960 loins and hams. Blood lactate levels were greater in the summer than in the winter (P<0.001). Stomach content was affected (P≤0.05) by season, on-farm fasting interval (P<0.001), lairage time (P<0.0001). The weight of stomach contents reduces as the total feed withdrawal time increases. However, this effect stoppeds after on-farm fasting of 17 h plus 1 h of lairage. Based on the analysis of principal components, the stomach content can be influenced by feed and water in different ways accoring to treatments. Only 8 h of on-farm fasting is not enough empty stomachs from feed content. On the other hand, an on-farm fasting period of 16 h or longer can also be a problem due to stomachs containing more water. These analysis suggested that after 16 h of on-farm fasting pigs get hungry and start to drink water in order to maintain satiety, while it is not observed during on-farm fasting of 12 h even after 6 h of lairage. Carcass lesions caused by fighting were greater (P≤0.005) in the winter, mainly after 3 and 6 h of lairage (P≤0.005). There was an interaction between season and lairage time on pH_μ of loin and ham, where pH_μ was lower (P≤0.05) for pigs slaughtered after six hours of lairage during the summer. The application of 12 h of on-farm fasting with 6 h of lairage seemed to be best combination to reduce stomach content weight (feed and water). Mainly in the winter, shorter lairage period can be used to reduce percentage of skin lesions and better pork quality traits in pigs.

Keywords: cortisol, feed withdrawal, lactate

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Introduction

Feed withdrawal and holding in the lairage are common commercial practices during preslaughter handling. The benefits they provide to farmers, transporters and the abattoir include feed saving on-farm, prevention of animal losses and travel sickness during transport, reduced carcass contamination due to lower risk of gut content spillage during carcass evisceration, recovery from previous stress before arrival at abattoir and improvements in pork quality. The lairage period provides a reservoir of animals for the slaughter line, levelling out variations in the delivery schedule to the plant, and it also allows pigs to recover from any previous stress. During this period, pigs can rest and recover from any previous stresses and dehydration that occurred during transport from the farm to the abattoir. A lairage period of 1–3 h has been recommended for its benefits to the welfare of pigs and meat quality, without imposing important harmful effects such as long feed withdrawal, skin and carcass damage and meat quality (Dalla Costa et al., 2016). Longer lairage periods may increase the risk of fighting in mixed groups of pigs resulting in a higher incidence of pigs with skin and carcass damage and pork quality defects (Guàrdia et al., 2005; Dalla Costa et al., 2016). Thus, based on the potential advantages of applying different combinations of on-farm fasting interval and lairage period, further research is needed to understand and confirm these effects under commercial conditions (Panella-Riera et al., 2012)

Most studies were conducted in the same period of the year and in countries where the climate conditions are relatively stable. However, the effects of feed withdrawal during different seasons on animal welfare, stomach content, and carcass and pork quality may vary depending on environmental conditions. It is known, in fact, that thermic stress has an impact on pork quality (Guàrdia et al., 2005). However, the effects of the interaction between the combination of on-farm fasting intervals with lairage periods at different climates on animal welfare, stomach content, and carcass and pork quality have not yet been assessed. Thus, the objectives of this study were to study the effects and interactions of different combinations of on-farm fasting intervals and lairage period at different climates on blood stress parameters, and carcass and meat quality in pigs.

Material and Methods

All experimental procedures performed in this study were approved by the institutional animal care committee on the basis of the current guidelines of the São Paulo State University's Animal Research Ethics Board (protocol number 6119-08).

A total of 960 crossbred pigs (115±2 kg) originating from eight commercial swine growing-finishing farms located in Southern Brazil (Santa Catarina) were randomly selected, tagged, weighed and distributed into twelve groups of 20 pigs each according to each treatment. Treatments consisted in a combination of four different on-farm feed withdrawal periods (8, 12, 16, 20 h) with three different lairage periods (1, 3, 6 h). One day before shipping to abattoir, the pens were randomly assigned to each treatment of on-farm feed withdrawal. On achieving slaughter weight, each treatment group was loaded into trucks in groups of 4–5 pigs by a trained loading crew always using paddles and rattles. Pigs were shipped to the abattoir in groups of 60 pigs per replicate (or farm) during two seasons (summer and winter) over 8 transports (60 pigs × 2 seasons × 8 replicates). There was no rain during the period from loading, transport, unloading until the slaughter. Transport trials were run during the winter and summer of 2008 (June to August) and 2009 (March to May), respectively, with an average ambient temperature of 14 °C (range from 13 to 18°C) and 20.5 °C (range from 15 to 31°C) in the winter and the summer, respectively. The topography of the area of transport from farms to abattoir was usually flat, however, there are some steep slopes. All pigs were slaughtered in the same commercial abattoir under federal inspection service located 27°05′25″W (latitude) and 52°37′23″S (longitude). A total of 960 pigs (5 pigs/12 treatments/2 seasons/8 repetitions) were used for the analysis of blood stress indicators (cortisol and lactate) in the sticking wound blood. The stomachs of pigs were collected directly on the dressing line during evisceration process. They were identified by a tag and stored at 4ºC until the moment of weighing. All stomachs were weighed full and emptied of their content. The weights of stomach content are expressed on a wet weight basis. Indeed, the stomach content was collected and subjectively scored. According to a visual score, the following categories were established: full of only water and mucus (no feed content), mix of water and feed usually in a proportion of 50% approximately), and full of only feed. In the chiller, carcass lesions were assessed on each left carcass side and classified as fighting-type lesions or mounting-type lesions by visual assessment of shape and size according to the photographic standards as described by Faucitano (2001). Meat quality was assessed in 960

carcasses (5 pigs/12 treatments/2 seasons/8 repetitions) by measuring pH at 45 min and 24 h *post-mortem* (pH_i and pH_u, respectively), colour using Minolta Chromameter and Japanese color standards (Nakai et al., 1975) and drip loss according to a modified EZ-DripLoss procedure (Correa et al., 2007) in the *Longissimus dorsis* and *Semimembranosus* muscle.

Data was analyzed as factorial design (4x3; on-farm fasting interval x lairage period) to check effects of treatments. Frequencies of lesions and stomach content data were log-transformed and expressed as the square root of (x + 1). The model included effects of farm, season, on-farm fasting interval, lairage period, interaction between season, on-farm fasting interval and lairage period, and error supposedly homoscedastic, independent and normally distributed. Variance analysis using GLM SAS (2003) was applied to study each effect factor of the model using the group as experimental unit for the analysis of stomach weight and content data, and the individual as the experimental unit for the analysis physiological and meat quality data, and farm was the adopted repetition. A complementary analysis of response surface was performed when any effect was present. The likelihood ratio and chi-square tests were used to compare the skin lesion-type categories. Stomach weight content data was analyzed by logistic regression considering the same effects of variance analyses. The tests were performed using the FREQ procedure of SAS (2003) with Tukey test for mean comparison. The means of stomach content weight was standardized and submitted to a multivariate analysis using Principal Components Analysis Statistica 7 in order to better understand the behaviour of these variables in each cluster. A probability level of $P < 0.05$ was chosen as the limit for statistical significance in all tests and probability levels of $P \leq 0.10$ were considered as a tendency.

Results and Discussion

Blood cortisol levels were not significantly influenced by treatments or season ($P > 0.05$). However, there was a significant effect of season (9.1±0.18 vs. 12.28±0.10 µg/dL; $P < 0.001$) on blood lactate level, which greater in the summer. The greater lactate concentrations indicated that pigs were more physically exhausted at exsanguination during the summer, which suggests the pigs were subjected to more stressful conditions in this season and may have been more difficulties to handle.

Stomach content was affected ($P \leq 0.05$) by season, on-farm fasting interval ($P < 0.001$), lairage time ($P < 0.001$), and an interaction between on-farm fasting interval and lairage time ($P < 0.01$) was found.). In the winter, pigs had heavier stomachs than in the summer (407.94±13 versus 395.88±14.6, $P \leq 0.05$). The weight of stomach contents reduces as the total feed withdrawal time increases. However, this effect stopped after on-farm fasting of 17 h plus 1 h of lairage. A longer overall feed withdrawal period resulted in lower weight of stomach contents (Fig. 1). Based on this analysis, the use of an on-farm fasting interval of 16 h combined to 1 h of lairage period had similar results to the use of 12 hours of on-farm fasting combined with 6 h of lairage. Thus, in order to obtain empty stomachs (<350 g of stomach content on average), both combinations (16_1 or 12_6) could be recommended. The analysis by principal components confirmed these findings and provided a better understanding of the behaviour of these variables according to the treatments. Based on the analysis of principal components (Fig. 2), the treatments are separated into two groups (SF and LF: shorter and longer on-farm fasting, respectively) with specific caracteristics. As indicated by the arrows, the SF group is mainly influenced by feed and water content and formed by treatments with on-farm fasting of 8 and 12 h, and the LF one by water content and has longer on-farm fasting intervals of 16 and 20 h. This clusters sugested that only 8 h is not enough obtain empty stomachs since it is strongly influenced by feed content. On the other hand, an on-farm fasting period of 16 h or longer can also be a problem due to stomachs containing more water. Interestingly, these analysis suggested that after 16 h of on-farm fasting pigs get hungry and start to drink water in order to maintain satiety, while it is not observed during on-farm fasting of 12 h even after 6 h of lairage. Thus, on this basis, an on-farm fasting of 12 h combined with 6 h of lairage is recommened in order to obtain empty stomachs (feed and water).

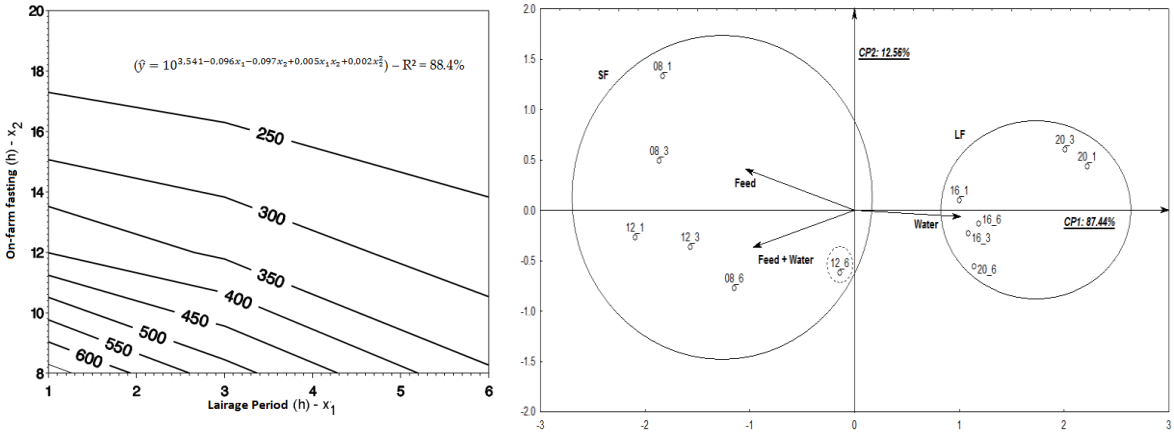

Figure 1 Analysis of response surface and principle components analysis of stomach weight of pigs according to on-farm fasting interval[1] and lairage time[2].
SF: Shorter on-farm fasting interval. LF: Longer on-farm fasting interval.
[1, 2] numbers in the figure separated by "_" means on-farm fasting interval and lairage period, respectively.

Carcass lesions were significantly influenced ($P < 0.001$) by season. In contrast to previous reports (Panella-Riera et al., 2012), independently of the season, lairage period affected the incidence of carcass lesions unlike on-farm fasting interval. Carcass lesions caused by fighting were greater ($P \leq 0.005$) in the winter, mainly after 3 and 6 h of lairage ($P \leq 0.005$). The higher number of carcass lesions observed in the winter, which were mainly caused by fighting, may have been linked to the pigs huddling together to better cope with cold temperatures (Guàrdia et al., 2005;). The huddling behavior increases contact between pen mates leading to fighting or climbing over the backs of other pen mates to find a place to lie down and rest, and this is the likely reason for the difference found between seasons. Dalla Costa et al. (2016) reported that non-fasted pigs showed a higher number of fights and a longer total duration of fights during lairage than fasted (18 h) pigs.

There was an interaction between season and lairage time on pH_μ of loin and ham, where pH_μ was lower ($P \leq 0.05$) for pigs slaughtered after six hours of lairage during the summer. In contrast to Panella-Riera et al. (2012), fasting interval did not raise pH_μ. Independently of the treatment and season, none of loins and hams had $pH_i < 6.0$ or $pH_u > 6$, which is indicative of PSE and DFD meat in pigs, respectively. However, mainly in the summer, pigs kept at lairage for longer (6 h) had a pH_u value lower than 5.5 in loin and ham, which may indicate a mild pork quality defect. This study confirmed the negative effect of warm season on meat quality. During the warmer seasons, several abattoirs have applied shorter lairage periods in order to obtain higher quality of meat, however, without the support of literature.

Conclusions

Based on these results, commercial practices such as an on-farm fasting interval and lairage period at the abattoir may significantly affect animal welfare, carcass and meat quality traits. Indeed, these practices interact with season, which should be taken into account whenever the effects of presalughter handling on animal welfare, carcass and meat quality traits are evaluated. The application of 12 h of on-farm fasting with 6 h of lairage seemed to be best combination to reduce stomach content weight (feed and water). Mainly in the winter, shorter lairage period can be used to reduce percentage of skin lesions and better pork quality traits in pigs. However, to obtain all this advantages, it is fundamental that producers and abattoirs establish a good communication channel to plan the logistics of this phase of preslaughter handling which can be done by technicians in cooperative systems or also by producers when planning the shipping of animals.

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References

CORREA, J. A., MÉTHOT, S. & FAUCITANO, L. (2007). A modified meat juice container (EZ-DripLoss) procedure for a more reliable assessment of drip loss and related quality changes in pork meat. Journal of Muscle Foods 18: 67–77.

DALLA COSTA, F. A.; DEVILLERS, N.; PARANHOS DA COSTA, M. J. R.; FAUCITANO, L. Effects of applying preslaughter feed withdrawal at the abattoir on behaviour, blood parameters and meat quality in pigs. *Meat Sci.*, **2016**, 119, 89–94.

FAUCITANO, L. Causes of skin damage to pig carcasses. Can. J. Anim. Sci. **2001**, 81, 39–45.

GUÀRDIA, M. D., ESTANY, J., BALASH, S., OLIVER, M. A., GISPERT, M., & DIESTRE, A. (2005). Risk assessment of DFD condition due to pre-slaughter conditions and RYR1 gene in pigs. Meat Science, 70, 709–716.

NAKAI, H., SAITO, F., IKEDA, T., ANDO, S. & KOMATSU, A. (1975). Standard models of pork colour. Bulletin of the National Institute of Animal Industry 30:69-74.

PANELLA-RIERA, N.; GISPERT, M.; GIL, M.; SOLER, J.; TIBAU, J.; OLIVER, M. A., VELARDE, A.; FÀBREGA, E. Effect of feed deprivation and lairage time on carcass and meat quality traits on pigs under minimal stressful conditions. *Livest. Sci*., **2012**, 146, 29-37.