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Physiological responses and blood gas exchange following long-distance transport of piglets weaned at different ages over unpaved or paved roads

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ABSTRACT

This study investigated the physiological changes associated with the prolonged transport of piglets weaned at three different ages: 10 (W_{10}), 15 (W_{15}) and 21(W_{21}) days under two experimental conditions: over an unpaved (UPR) vs. a paved road (PR). During the experiment the piglets were exposed to two stressors simultaneously: weaning and transport in a vehicle to the farm. The duration of each trip was approximately 6 h. The stress responses to weaning and transport were determined using blood physiological and metabolic profiles. Four blood sampling procedures were performed with all groups: 24 h before weaning while the piglets were at rest inside the piglet boxes (baseline levels); immediately after weaning but before transport; the third sample was collected upon the arrival of each group of piglets at the farm (PT_0); and final sample was collected 15 min after the arrival of each group (PT_{15}). In groups W_{10}, W_{15} and W_{10}, lactate concentrations at weaning-induced stress increased ($P<.05$) by almost 50% with respect to baseline levels ($P<.05$). At 15 min after arrival at the farm in W_{10} lactate concentrations increased by approximately 60% in the piglets transported via UPR, compared to PT_0 ($P<.05$). During weaning and the evaluation carried out immediately after transport, no significant changes in pH were observed in any of the three experimental groups. Later, however, pH decreased in group W_{10} after the PT_{15} stage compared to the PT_0 stage in the piglets transported by PR. Similar to the lactate levels, glucose concentrations in the piglets in the three age groups increased at the moment of weaning with respect to baseline levels ($P<.05$). However, glucose decreased in the PT_0 stage vs. weaning-induced stress only in groups W_{10} and W_{15} under both conditions, UPR and PR ($P<.05$). In relation to the PT_{15} stage for the three groups of piglets transported over the UPR, glucose increased with

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respect to the PT_0 stage ($P < .05$). These results indicate that the weaning process in piglets alters their acid–base balance by increasing lactate and glucose concentrations regardless of age at weaning. This hyperlactataemia is accentuated when the animals are transported for 6 h immediately post-weaning at 10 and 15 days of age, regardless of the conditions of the roadway used. The effects were the same in 21-day-old piglets but only when they were transported on the UPR.

1. Introduction

Age plays an important role in the weaning process, since the welfare and immune status of piglets are severely affected when weaning takes place prematurely (Gonyou et al., 1998; Kuller et al., 2004; Main et al., 2004; Niekamp et al., 2007; Roldan-Santiago et al., 2013b; Mota-Rojas et al., 2014). However, as swine-production units become larger there is a general trend towards the adoption of early, segregated weaning management systems (SEW) that may span 7, 14, 21 or 28 days. Such systems require transporting piglets to a different site (Berry and Lewis, 2001) with installations that separate them from the housing area for older pigs during a period when maternal antibodies are providing important protection. While SEWs break the cycle of diseases that can be passed from sow to piglet, and increase the latters' growth potential (Wamnes et al., 2008); SEWs require moving the piglets, and this represents an additional stressor since they experience mixing, crowding, food and water deprivation, changes in feed and environment, temperature fluctuations, vibration and noise, all of which create concern for their welfare (Hicks et al., 1998; Mota-Rojas et al., 2014; Roldan-Santiago et al., 2013b; Stephens and Perry, 1990; Wamnes et al., 2008). Taken together, these factors result in weight loss due to dehydration and food withdrawal (Roldan-Santiago et al., 2013a), and have detrimental effects on post-weaning performance (Nielsen et al., 2011; Robert et al., 1997). In this regard, it has been demonstrated that transport immediately after weaning can lead to an increased risk of diarrhoea with consequences for growth (Madec et al., 1998; McCracken et al., 1999; Roldan-Santiago et al., 2014). The deleterious effects on piglets associated with transport-induced stress could increase as a function of the conditions of the road over which the transport vehicle is driven. In Mexico, for example, many swine-production operations are often located in rural zones far from cities, such that access to and from them often entails transport over unpaved roads. Most of the literature pertaining to transport-induced stress in pigs has been conducted on market-weight hogs (Mota-Rojas et al., 2006; Averos et al., 2008a, 2008b), but in recent studies Becerril-Herrera et al. (2010) and Mota-Rojas et al. (2012a) demonstrated the usefulness of determining the levels of a series of physiometabolic variables, including lactate, pH, glucose and blood gases (pCO_2, SO_2) when evaluating stress and animal welfare in newborn and adult hogs transported to slaughter (Mota-Rojas et al., 2011, 2012b). In contrast, the study of the physiometabolic responses associated with the transport of weaned piglets at different ages has not yet been documented (Averos et al., 2008a, 2008b). Thus, the objective of this study was to determine the physiological changes associated with the prolonged transport of piglets weaned at three different ages: 10, 15 and 21 days, under two road conditions: over an unpaved vs. a paved road.

2. Material and methods

2.1. Location

The study was conducted in accordance with the guidelines for the ethical use of animals in applied ethological studies, described elsewhere (Sherwin et al., 2003). The piglets used in this research received appropriate treatment and care from the beginning of the study and throughout their handling, including full compliance with the official norm NOM-062-ZOO-1999. The experimental protocol of the study was approved by the Doctoral Commission of Biological Sciences and Health of the Universidad Autónoma Metropolitana, Mexico City, Mexico, and was carried out at the Swine Centre facility of the Faculty of Veterinary Medicine at the Universidad Nacional Autónoma de México (UNAM).

2.2. Piglets and treatments

A total of 180 hybrid piglets born to York-Landrace sows and Pietrain sires were utilised, and 720 blood samples were taken. In regards to the original litter, the piglets with the heaviest weights (two piglets form each littler, female and male) were transported from the litter for each experimental condition. This is to say from multiple litters, but always considering the same inclusion criteria.

The piglets were transported at 10, 15 and 21 days of age and at average weights of $3.17 \pm .50$, $5.13 \pm .71$, and $7.09 \pm .48$ kg, respectively. While in the birthing area, the piglets remained with the sows in individual crates with metal grid flooring. Each crate was equipped with a moulded plastic piglet box (1.45 m long × .52 m wide × .57 m high) with an integrated solid plastic floor situated in front of the crate. The average temperature in the maternity area was 32 °C and relative humidity was 65%.

The piglets received pre-starter feed ad libitum from 4 days of age until weaning. The feed contained 1.25% lysine and 20% raw protein. During the experiment, therefore, the piglets were exposed to two stressors simultaneously: weaning and transport in a vehicle to the farm. It is