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Air quality determination in an Optirat® Plus cage with a modified wire bar lid

Introduction

Individually ventilated cages have lids that restrict air exchange when the cage is not mechanically ventilated. Because researchers may require cages removed from racks for extended periods of time for experimental purposes, the aim of the present study was to determine the effectiveness of a new wire bar lid design for Optirat Plus cages in sustaining adequate air quality when the cage is not mechanically ventilated on the rack.

Materials and Methods

The Optirat Plus (Animal Care Systems, Inc.) cage top normally has an exhaust filter sandwiched between a stainless-steel grid and a rear plastic cover, when used with mechanical ventilation (fig. 1a). The filter assembly was removed and replaced with a wire-bar insert (fig. 1b) for the modified lid. Oxygen levels were measured using the BW Honeywell GasAlert 0_2 Extreme gas monitor placed directly inside the cage; cage and room temperature and humidity were measured with a Sensorion temperature/humidity sensor. Ammonia levels were measured using the Pacific Sentry LLC Small Animal Ammonia Sensor placed directly inside the cage for the duration of the experiment.

Figure 1a

Figure 1b

Five trials were undertaken with Optirat Plus cages (Trials 2, 3 and 4 with a mezzanine and trials 1 and 5 without) with modified wire-bar lids, aspen chip bedding and 3 female rats per cage. The rats were placed in a new cage at the start of each trial, performed on separate consecutive days. Female Sprague Dawley rats (n=3; 295 ± 4 (SD) grams) were used for trials 1-3; and female Wistar and Long Evans rats (n = 2 and 1, respectively; 513 ± 175 (SD) grams) for trials 4 and 5. Temperature/humidity and oxygen and ammonia levels were determined during both the light and dark phases of the cycle under controlled lighting conditions (12-h light:dark cycle; lights on at 0600 h). Trials ended when ammonia levels in the cage exceeded 25 ppm.

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Results:

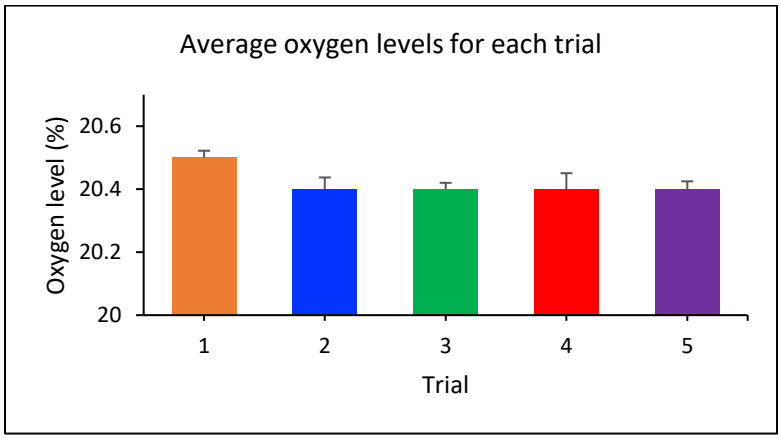

Figure 2. Average oxygen levels in the cage for each trial 1-5. Oxygen levels averaged 20.4% ± 0.03 (SEM) for the entire study. The single lowest oxygen value measured was 20.1% in trial 4. Atmospheric oxygen is 20.9%.

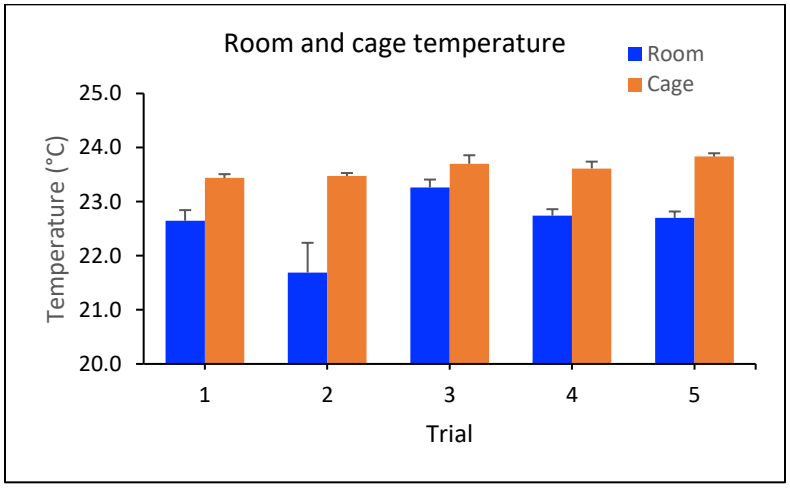

Figure 3. Average room and cage temperature for each trial 1-5. Cage temperature averaged 1.0 Celsius ± 0.2 (SEM) higher than room temperature.

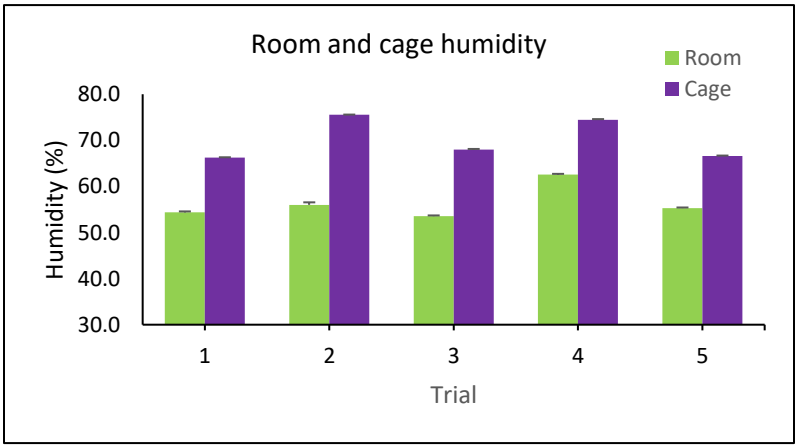

Figure 4: Average room and cage humidity for each trial 1-5. Cage humidity averaged 13.8% ± 1.5 (SEM) higher than room humidity.

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Discussion

The use of individually ventilated cages is commonly used to protect animals against infections and staff against allergens; however, these sealed systems may lead to problematic air quality when cages are left off the rack without mechanical ventilation for extended periods of time[1,2,3]. Although no acceptable exposure limits have been set for laboratory rodents, no dramatic effects on physiology can be observed for CO_2 levels up to 1.0%[4,5]. Until further studies are conducted to investigate reactions when exposed to different levels of CO_2, the scientific literature suggests that animals exposed to CO_2 levels above 1.5% should be used for experimental purposes with caution and allowed a few days of recovery after exposure. Although CO_2 levels were not directly measured in this study, oxygen is inspired, and CO_2 is expired by the animals in each cage displacing the level of oxygen; therefore, the depletion of oxygen can be directly attributed to the production of CO_2. The presence of gases other than oxygen in atmospheric air are negligibly low and do not contribute significantly to changes in oxygen level; any changes would be correlated to a slightly lower CO_2 level than derived in this study.

CO_2 levels derived averaged 0.5% over the 5 trials and 0.8% at the lowest in any one trial, remaining well below the cited level of 1.5% whereby animal physiology and behavior are impacted. We conclude that using the modified wire-bar lid in the Optirat Plus cage at the maximum number of rats allowable per cage floor area, and tested in the current environmental conditions, resulted in air quality at an acceptable value for animal well-being.

Since ammonia levels exceeded 25 ppm at the earliest on day 4 after initial cage change, a cage change frequency of at least twice a week is recommended when the maximum number of rats allowable per floor space are housed.

Acknowledgements

We would like to thank Teresa McKernan and Austin Corell for technical assistance.

References

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