Analysis of Paired Breeder Performance in an Animal Care Systems Optimice® ventilated rack after transfer from both open-top cages and a motorized ventilated rack*

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Introduction

Breeding of laboratory mice is an integral part of most institutional animal care programs. Breeding performance plays a crucial role when applying the 3Rs of research, especially the reduction in animal numbers (i.e., fewer breeding pairs required). There are many different caging systems and technologies available in the industry, all providing varied microenvironments for the animals. Our institution evaluated an Animal Care Systems Optimice rack demo and compared breeding performance in this low-flow ventilated carousel rack to our motorized ventilated library-style rack and open-top cages.

Methods

Mice in this study were bred in-house as pairs. Room temperatures ranged from 21-25°C, humidity was set between 40-60% and light cycle at a 12:12-h light:dark photo period. All cages contained corncob (Bed-o'Cobs, Andersons Lab Bedding, Maumee, OH), nesting material (Nestlets cotton squares, Ancare, Bellmore, NY) and one plastic shelter. In addition, all Optimice and open-top cages, and some (but not all) motorized cages were provided with Enviro-dri (Shepherd Specialty Papers, Watertown, TN). Sunflower seeds and millet were given on cage change days and when cages were opened. Mice in motorized and open-top cages were provided with rodent chow (diet 2018, Teklad Global, Envigo, or 50/50 mix of diets 5053 and 5058, LabDiet, St. Louis, MO) and mice in Optimice cages with diet 2018 (Teklad Global, Envigo), all ad libitum. Open-top cages were changed weekly and both types of ventilated cages were changed every 2 weeks. When new litters were noted, cage changing and other disturbances to the cage were postponed for up to 3 days. If pups were deemed too small to wean at 21 d, they were permitted to remain with the parents for additional days as needed.

Mice had been breeding in either conventional wire-bar open-top cages or library-style motorized individually ventilated cages (IVCs) at time of transfer. Animals from the open-top cages were moved from one building to the Optimice rack (see Figure 1) in another building. Animals housed in the motorized IVCs were moved from one room to the Optimice rack in a different room within the same building. Total floor space in the open-top cages was 65 sq in (419 sq cm), 93 sq in (600 sq cm) in the motorized cage, and 75 sq in (484 sq cm) in the Optimice cage. Breeding data were retrieved from in-house records.

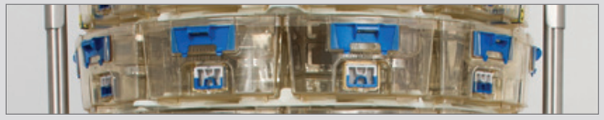

Figure 1: Optimice rack (Animal Care Systems, Inc., Centennial, CO)

Results

Data were collected between July 2017 to May 2018 from 7 breeding pairs of multiple transgenic strains (see Table 1) bred to a C57Bl/6 or unknown background strain and summarized for wean to born ratio, for all caging types. Because the same females were used pre- and post-Optimice, only wean to born ratio was calculated.

Female	x Male
LgH +/+ GFP	HCD20
LgH +/-	LgH +/+ GFP
CRE/TG	CRE/TG
CRE/CCN2	Unknown
CRE/CCN1/TG	Unknown
CRE/CCN1/CCN2	CRE/CCN1/CCN2
CRE/CCN1/CCN2	CCN1/CCN2

Table 1: Genotypes of female and male breeding pairs

	Open-top Cages	Optimice Rack
Average age of female mice when last litter was born	167	237
Wean to born ratio	0.33	0.73

Table 2: The average age of the females when their last litter was born in the open-top cages was 167 days of age. These same females continued to breed after being moved into the Optimice rack and averaged 237 days of age when retired. The average wean to born ratio was 0.33 in the open-top cages vs. 0.73 in the Optimice rack, an improvement of 121% in the Optimice rack.

	Motorized Rack	Optimice Rack
Average age of female mice when last litter was born	216	286
Wean to born ratio	0.33	0.60

Table 3: The average age of the females when their last litter was born in the motorized rack was 216 days of age. These same females continued to breed after being moved into the Optimice rack and averaged 286 days of age when retired. The average wean to born ratio was 0.33 in the motorized rack vs. 0.60 in the Optimice rack, an improvement of 82% in the Optimice rack.

Discussion

Reproductive performance can vary significantly at different institutions due to environmental factors which include caging type and level of noise and vibration. Loud or continuous noise, vibration, and bright light (to name a few) can all cause stress and decreased breeding performance in laboratory rodents[1,2]. Animal Care Systems racks utilize a unique technology free from motors and blowers, and therefore noise and vibration. Light distribution in the carousel rack is less variable compared to library style racks[3]. The low airflow, which rodents prefer[4], avoids introduction of air turbulence and high air velocity in the cage.

In this study, wean to born ratio improved 121% and 82% after mice were moved from the open-top cages and motorized rack, respectively, into the Optimice rack. This is remarkable considering they were much older when transferred to the Optimice rack and continued to breed until an average of 237 and 286 days of age. The Jackson Laboratory's statistics for C57Bl/6J mice recommends euthanasia at 210 days of age, with an average wean to born ratio of 0.8[5].

There are a few limitations to this study – the Optimice rack was housed in a different building from the open-top cages and in a different room from the motorized rack, and potential building and room variables, as well as environmental enrichment and feed were not controlled. However, the improvement in breeding performance, and at an advanced maternal age in the Optimice rack can likely be partially attributed to the performance of this rack – an absence of known rodent stressors (noise, vibration, high variation in light exposure and high air velocity and turbulence) and an enhanced cage microenvironment.

References

[1]https://www.jax.org/jax-mice-and-services/customer-support/technical-support/breeding

[2]Reynolds, Randall P; Li, Yao; Garner, Angela; Norton, John N. Vibration in mice: A review of comparative effects and use in translational research. Animal Models and Experimental Medicine, Volume 1, Issue 2, June 2018, pp. 116-124

[3]https://animalcaresystems.com/images/uploads/pdfs/Light_study_Optimice_9-Jan-2019.pdf

[4]Baumans, Vera; Schlingmann, Freek; Vonck, Marlice; van Lith, Hein A. Individually Ventilated Cages: Beneficial for Mice and Men? Journal of the American Association for Laboratory Animal Science, Volume 41, Number 1, January 2002, pp. 13-19(7)

[5]http://ko.cwru.edu/info/breeding_strategies_manual.pdf

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