Using environmental enrichment and nutritional supplementation to improve breeding success in rodents

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Maintaining valuable strains of rodents is essential for advancing science. Successful breeding programs are key to ensuring those lines are sustained. Breeding success, however, can be variable and sometimes non-existent, putting those lines at risk. Reducing stress in breeders by improving nutritional status, providing foraging opportunity or modifying husbandry procedures such as offering shelter or nesting enrichments can help improve breeding success.

Nutrient supplementation and foraging opportunities improve breeding success

Stress can have a significant impact on an animal's physiology, including negative effects on breeding and pup survival. Stress can present itself in breeding rodents through cannibalizing or neglecting litters, decreasing pup survival. Disturbances such as frequent handling and changes in noise and vibration levels can decrease breeding performance and induce the mothers to cannibalize their pups. This can be seen with many transgenic animals and stressed or new dams. Nutritional support can help the dam raise her litters by providing supplemental nutrients and an opportunity for foraging. Supreme Mini Treats™ are an aromatic, nutritionally complete flavored pellet made from a purified diet that provide easily digestible protein and nutrients for dams after delivery. Providing Supreme Mini Treats after the dam has her pups has been successfully demonstrated to decrease cannibalism. The aromatic pellets distract and de-stress the mom and provide highly digestible nutrients post-delivery. The mom spares her pups and consumes the treat instead.

The success of nutritional supplementation was demonstrated in a research lab breeding a transgenic mouse on the C57BL/6 background[1]. The strain had small litter size, poor breeding success and, most problematically, 100% abandonment of pups. To increase pup survival, the lab had been relying on foster dams. However, when they started providing the breeders Supreme Mini Treats two times per week beginning at gestation, all dams that received Supreme Mini Treats gave birth compared to only 20% of the non-supplemented breeders. Additionally, seventy weanlings survived with supplementation compared to thirteen when these same dams were not provided with Supreme Mini Treats. Although the exact mechanism for the improved breeding was not identified, the treats potentially provided additional nutrients needed by the dams to support reproduction and lactation in this model.

FIGURE 1 | One supplement that has shown effectiveness in improving breeding in difficult strains is Love Mash™. Love Mash is a high fat supplement specifically formulated for breeding mice.

Foraging treats such as dried mealworms, which also provide a source of high quality protein, have been demonstrated to decrease cannibalism induced by construction noise and vibration in a lab animal facility. By providing dried mealworms in breeding cages prior to changing rooms, an investigator was able to move the cages five times during the construction period and never lost a single pup to cannibalism. Another facility reported high levels of cannibalism in their transgenic mice. By providing the dried mealworms to both the moms and pups, cannibalism was eliminated. Additionally, it was noted that pups had more fur on their coat when supplemented with the dried mealworms.

Sunflower seeds, another nutritionally dense foraging supplement providing protein, unsaturated fatty acids, vitamins and minerals decreased cannibalism in a transgenic model of Rett syndrome[2]. Providing a handful of seeds to the breeding cages 3 days prior to delivery of the pups significantly increased pup survival over non-supplemented controls.

When providing nutritional support to breeding rodents, it is important to note that what works for one particular strain may not increase breeding success in another strain. Some strains do better on a lower fat diet as they can become obese on a high fat breeder diet and overweight males are poor breeders. Jackson Labs recommends C57BL/6 mice be maintained on a diet containing 6% fat for optimum breeding while BALB/cJ mice breed better on a 11% fat breeder diet[3]. Some smaller strains may need an additional fat

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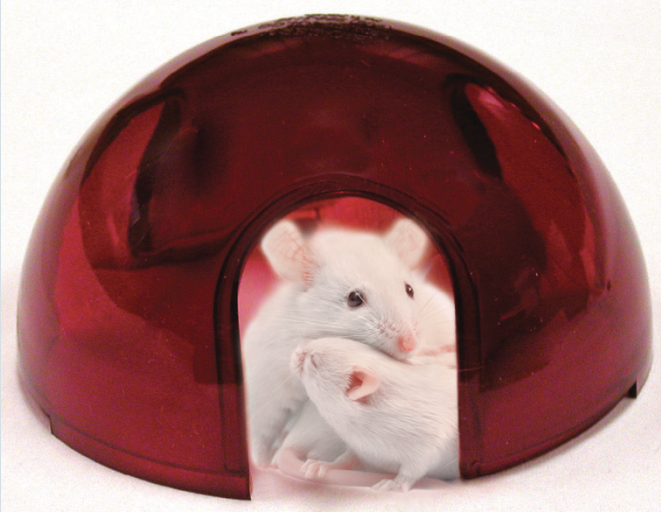

FIGURE 2 | The findings showed they weaned 76% more pups when the dams were provided a Mouse Igloo® versus no Mouse Igloo.

supplement to support lactation and the high energetic demands of breeding. One supplement that has helped improve breeding in difficult strains is Love Mash. Love Mash is a high fat supplement specifically formulated for breeding mice (**Fig.1**). The source of fat is cod liver oil, which provides an enriched source of omega-3 fatty acids. Omega-3 fatty acids have been demonstrated to help improve breeding in both males and females[4–5]. Love Mash can work in conjunction with maintenance or breeder diets and provides a foraging opportunity, which can decrease stress in both males and females. Empirical data from facilities using Love Mash has shown a 40% increase in litter size, increases in fertilization rate and milk production, and an increase in pup body weight in some strains. Additionally, the females had higher quality embryos (lower percentage of abnormalities) when supplemented with Love Mash[6]. Previous research has documented that an omega-3 enriched diet given to mice improved egg quality and fertility in advanced maternal age providing further support for the additional omega-3 fatty acids to the diets of poor breeders.

Shelters and nesting offer sense of safety and improve thermoregulation

Rodents are prey species and their need for shelter is hard-wired for them to feel safe from danger. In cages without shelter or nesting material, many strains display negative physiologic effects and behaviors such as a decrease in breeding. Breeding mice use shelters or nesting material to build nests and more efficiently thermoregulate. A recent study looking at paper nesting material and its effect on breeding performance in mice demonstrated that more pups were weaned in a nested environment[7]. The mice with paper nesting material could better regulate their own body temperature as well as that of their pups; their energy savings were redirected to producing more pups. The non-nested control mice were dramatically less feed efficient and produced far fewer pups. Another unpublished study at a large academic institution compared several hundred ventilated breeder cages with and without out a Mouse Igloo. The findings showed that 76% more pups were weaned when the dams were provided a Mouse Igloo (**Fig. 2**). Keen observations found these intelligent moms were protecting their pups from chilling and dehydration by strategically placing the Mouse Igloo and building their nests outside of that shelter to deflect airflow off the pups.

Stress can be reduced further by using shelters made of red or opaque material. They cannot perceive visible light through a red material because their retinas are insensitive to the red end of the color spectrum[8]. This provides a sense of darkness to the rodents but still allows humans to visibly observe the animals in the shelter. An example showed that adding a 3″ length PVC tube to a SLB mouse colony with poor reproduction and poor pup survival increased the percent viable litter from 68 to 94% and the pregnancy rates from 84% to 97%.

Reducing stress is fundamental to enhancing breeding success in rodents. Allowing rodents the opportunity to engage in natural behaviors such as foraging, sheltering and nesting increases fertility, pup survival and the number of pups weaned. Providing appropriate diets and nutritional supplementation to support the energetic demands of breeding and lactation can improve breeding success in rodents.

Company profile

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