

FEMALE MATE CHOICE CONSEQUENCES IN MATING SYSTEM OF ALBINO MICE *MUS MUSCULUS*

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ABSTRACT

Good genes models of mate choice predict additive genetic benefits of choice whereas the compatibility hypothesis predicts nonadditive fitness benefits. Here it was investigated female mate choice in the mating system of albino mice *Mus musculus*. It was conducting a controlled mating choice experiment whereby females were free to choose among two males that could not physically interact and female visiting rate and duration used to measure mate choice. In addition, mate choice test coupled with a cross-classified breeding design were used to study offspring fitness of preferred and non-preferred males. Females showed a significant difference in male preference. The survival and weight of offspring to independence was significantly correlated with female mate preferences. A lack of strong congruence in female preference for males suggested a role for compatibility in mate choice. Moreover, It is suggested that male genetic benefits which might be compatibility is most likely detected by odour cues but still need more studies.

Key words: sexual selection, mate choice, mate choice benefits, albino mice

1. INTRODUCTION

Sexual selection arises through intersexual variance in reproductive success, with variance usually higher in males due to their greater potential reproductive rates, a result of differences in gamete allocation between the sexes. Two main mechanisms of sexual selection are recognized. Intrasexual selection typically involves male–male competition; males actively compete for access to females or resources that are necessary to attract females. Intersexual selection gives rise to selection for male fighting ability, often including weapons and large body size. Intersexual selection involves some aspect of mate choice, usually by females, with preferences based on direct or indirect (or both) benefits and giving rise to selection for elaborate signals and displays by males and preferences for these traits by females (Fisher 1930, Anderson 1994, Williams and Burt 1997).

Females may perform mate choice based on direct, non-genetic benefits provided by the male which can increase female survival or fecundity, such as protection from predators or harassment by other males, access to resources or nuptial gifts, or parental care of offspring (Kirkpatrick 1982, Andersson 1994, Qvarnström and Forsgren 1998). With direct benefit models of sexual selection, the quality of benefits themselves is the principal criterion of female mate preference (Robert 1972). Female may also obtain indirect, genetic, benefits from potential mates,

which may enhance offspring fitness and reproductive success. Under indirect benefit models mate preference is selected through male genetic quality (Kirkpatrick 1982, Eberhard 1996).

Under a “good genes” model the prediction is that female mate preferences are under selection through the choice of males that father offspring of superior viability. Females can evaluate male viability using exaggerated male traits or behaviours that honestly indicate male genetic superiority (Casalini 2007). Zahavi 1975 suggested that elaborate male ornaments is a handicap and males with such ornaments show their physical quality by illustrating that, despite having such a handicap, they can survive. For example, a female mate preference for a long-tailed male is guaranteed a good quality partner, because only high-quality males can afford to carry the long tail handicap, while male of low quality would simply be unable to survive with such a costly trait. In addition, Hamilton and Zuk 1982 proposed that, healthy males could advertise the fact that, they are free from diseases and parasites possibly with possess such encumbrance ornaments since, disease is a major cause of juvenile mortality.

Another mechanism for indirect mat selection is through genetic compatibility. Here a females enhances her offspring's viability by mating with a male that is genetically compatible. in contrast to good gene models, the viability of offspring is only improved when specific male and female haplotypes are coupled where, female preference is restricted to particular genetic combination (Zeh and Zeh 1996). Therefore, compatible genes are anticipated to demonstrate non-additive variation and females will not necessarily share mate preference in populations operating with compatible gene mechanism (Neff and Pitcher 2005).

Numerous studies of female mate choice have been focused on more ornamental classes, mostly birds and fish (Clutton-Brock and McAuliffe 2009). However, in recent years more and more studies have provided evidence that mammals female choose to mate with males which provide them and their offspring with fitness benefits (Jennions and Petrie 2000, Roberts and Gosling 2003). In animals in which there is no size dimorphism, females are likely to have more freedom to exercise their choice even in more naturalistic situations. The basis of female reproductive mate choice, and their outcomes for females and their offspring, are important in understanding sexual selection (Robert 1972 , Andersson and Simmons 2006). The goal of this study was to investigate the consequences of female mate choice in albino mice *Mus musculus*.

MATERIAL AND METHODS

Study species and Husbandry

An experimental study to understand the basis to female mate choice, requires a suitable model which shows unambiguous mate choice, and is amenable to lab manipulation. It should achieve sexual maturity within a timescale that is practical for replicable experimental protocols, and reproduce year round. Mice *Mus musculus* Linnaeus, 1758 of albino strain are polyestrous mammals with only a small decline in fertility during the winter season. Females, become mature from the age of 3–4 weeks. All females older than 8 weeks are able to reproduce, exhibiting a typical cyclic sexual activity. In male sexual maturity occurs slightly earlier, sometimes as early

as 5 weeks, usually at 6–8 weeks. The female reproductive cycle, the estrous cycle, lasts 4–6 days (Guenet 2015). Synchronization of the estrous cycle by the presence of a male has been reported (Whitten 1956). It is a consequence of the dispersion in the environment of volatile pheromones that are at high concentration in the urine of males, these pheromones interfere with the hormonal control of the female cycle (Guenet 2015). The gestation period ranges from 19 to 22 days but this depends upon a number of parameters. For example, females that are pregnant for the first time (primiparous) deliver their progeny up to 1 day before multiparous females. At the end of the gestation period, the behaviour of the female changes dramatically, the female is hyperactive and prepares a nest in a corner of the cage, preferably in a darker area. Lactation for newborn mice normally lasts 3–4 weeks depending on the number and degree of vigour of the pups. In the mouse, the number of neonates is frequently greater than the number of nipples, but this is not a problem and the pups are generally fed adequately, from the age of 12–14 days, the young mice start eating solid food and the mother's milk is only a complement to the diet (Guenet 2015). Animals were bred with genetically distant individuals as far as possible, in order to keep a healthy, out bred, population. Animals were separated from opposite sex siblings before sexual maturity and from same sex siblings shortly thereafter. Then animals were housed in individual tanks (35x23x22 cm) with wire mesh lids until required. Cages containing either females or males were kept on different racks and a partition between them prevented visual contact between males and females. Mice were fed ad libitum with seed mix (consisting mainly of millet and some sunflower seeds) enriched with insect additive (Orlux Insect Patee, Versele-Laga, Deinze, Belgium). Water were provided from a dropper bottle. Each cage was contained an artificial shelter, wood shavings for bedding, straw for nest building, and at least one dried millet spray, suspended from the lid, as a source of food and behavioural enrichment, in terms of food handling and climbing.

Experiment procedure

The experimental arena measured (28x35x58.5 cm) in (figure1) was used for female mate choice test. Here, three blocks were tested, each block consist of two replicates with two males and two females. Before each trial, females were checked for oestrous condition by means of a vaginal smear (McLean et al. 2012), and were housed in the central chamber, two males were haphazardly selected from the stock terrarium and assigned randomly for the side chambers, the males were left to habituate to the chambers for an hour. Following the habituation period, the barriers between the chambers were removed allowing the female free movement throughout the arena. The animals' behaviour were recorded for 30 min. The number and duration (to the nearest second) of the female visits to each side of the arena were recorded as measurements of mate preference. The first tested female was removed from the experimental arena and same procedure was repeated with a new female. Thus, a total of 4 males and females were used in independent trails. The whole arena was cleaned and disinfected following each trial. The experiment was replicated 3 times with 6 different females in oestrus and 6 males. After completion of the mate choice trial (previous test) females were isolated until became oestrous again and mated with same males used in the mate choice trial separately. Firstly, females were checked for oestrous condition

by means of a vaginal smear (McLean et al. 2012). Secondly, females were assigned randomly to mate with preferred and non-preferred male for two days, and males were removed from females terrarium and females were checked for pregnancy (Silver 1995). After females birth, number of offspring were counted and a record was kept of their survival and weight over a period of two weeks, (after which time the offspring achieve independence).

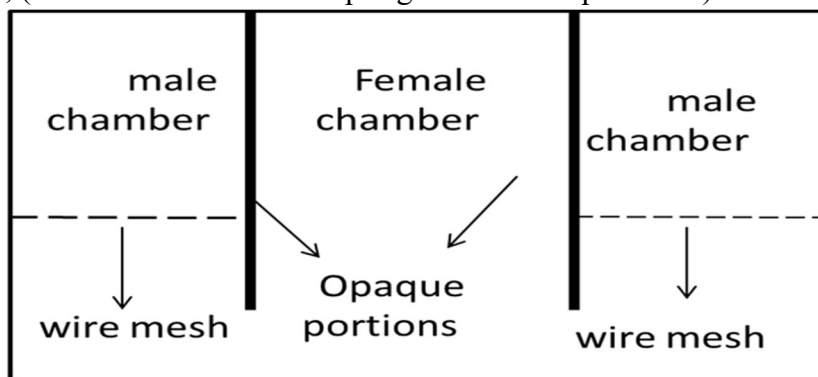


Figure1. Experimental area for live mate choice test.

Statistical analysis

All data were tested for normality using a Kolmogorov–Smirnov test and for equality of variance using Bartlett’s test. Two-sample t-test was used to test differences between behavioural data in terms of female visiting number and duration.

For measures of offspring fitness traits, pairwise comparison of the offspring fathered by preferred and non-preferred males were performed using two-sample t-tests. Two-way ANOVA was used to test all the interactions between dependent variables.

RESULTS

The results showed that, there was a significant difference in female visiting rate between preferred male (11.00 ± 0.63) and non-preferred male (7.33 ± 0.95) (T-Test: DF =9, T=3.20, P=0.013) (Fig2).Furthermore, there was a significant difference in female visiting duration between preferred male (82.5 ± 9.5) and non-preferred male (45.3 ± 9.7) (T-Test: DF =9, T=2.75, P=0.023). (Fig3).In addition, male preference had a significant effect on female visiting rate and female visiting duration (Two-way ANOVA: F=9.31, P=0.014),(Two-way ANOVA: F=6.99, P=0.027) respectively (Table 1). Whereas, there was no effect of male chamber (Two-way ANOVA: F=0.08, P=0.788), (Two-way ANOVA: F=0.26, P=0.622) respectively or male preference \times male chamber on female visiting rate and female visiting duration (Two-way ANOVA: F=0.67, P=0.0438), (Two-way ANOVA: F=0.03, P=0.871) respectively.

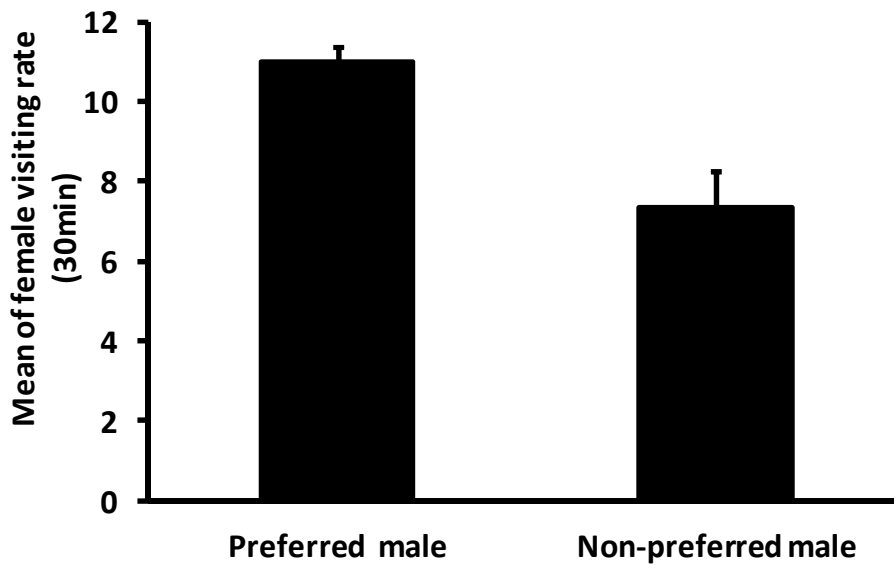


Figure 2. Male female visiting rate (\pm SE) in relation to male preference.

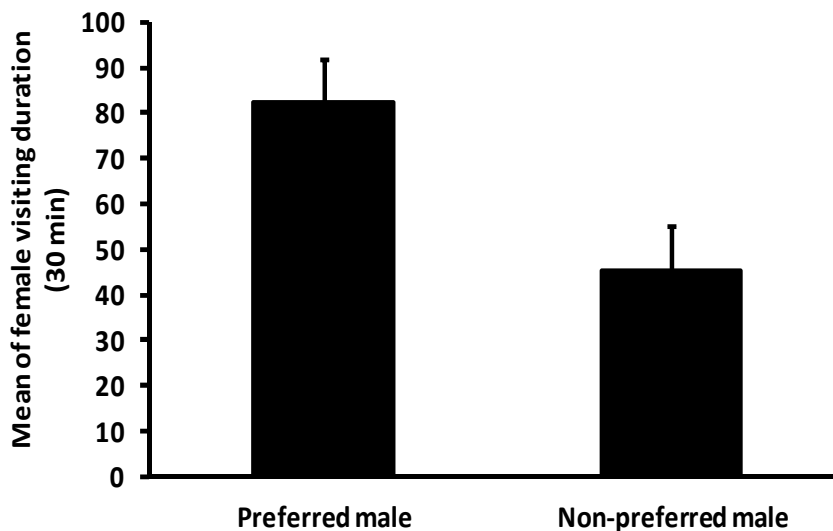


Figure 3. Male female visiting duration (\pm SE) in relation to male preference.

The findings showed that, there was a significant variation in the mean number of offspring of preferred male (5.33 ± 0.99) and non-preferred male (2.667 ± 0.33) at birth (T-Test: DF =6, T=2.56, P=0.043) (Fig4). Moreover, the survival rate of offspring at one week old showed a significant difference among the progeny of preferred male (4.67 ± 1.2) and non-preferred male (0.67 ± 0.42) (T-Test: DF =6, T=3.08, P=0.022) (Fig5). Similarly, there was a significant difference in offspring survival rate of offspring of preferred (4.33 ± 1.4) and non-preferred male (0.500 ± 0.34) at two weeks old among preferred male and non-preferred male a significant

different (T-Test: DF =5,T=2.74,P=0.041) (Fig6). Additionally, the weight of offspring of preferred male and non-preferred male varied significantly when the offspring were one week (3.39±0.56) and non-preferred male(1.02±0.65) at two weeks old preferred male(5.17±1.1) and non-preferred male (1.15±0.75) (T-Test: DF=9, T=3,40,P=0.008) (Fig7) and (T-Test: DF=8 T=2.94,P=0.019) (Fig8) respectively.

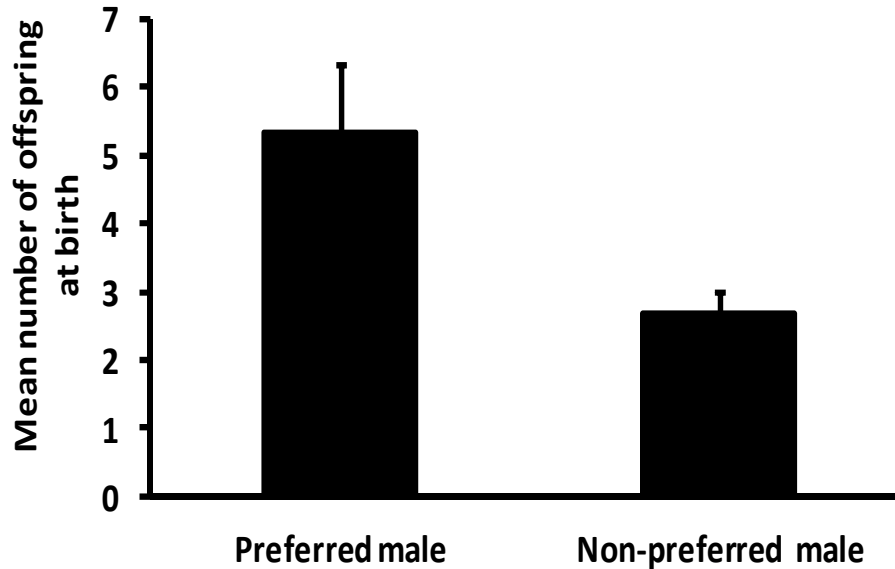


Figure 4. Preferred and non-preferred male number of offspring of mean (±SE) at birth.

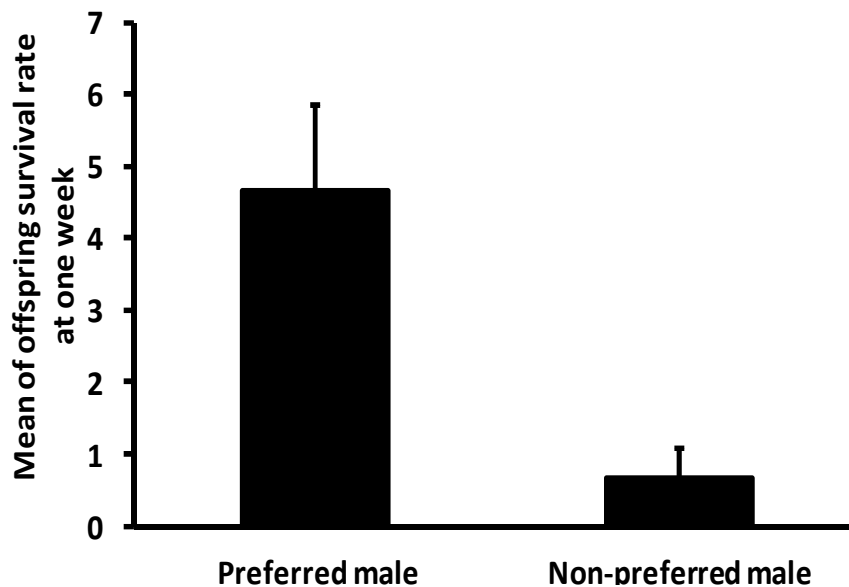


Figure 5. Preferred and non-preferred male of offspring survival rate mean(±SE) at one week old.

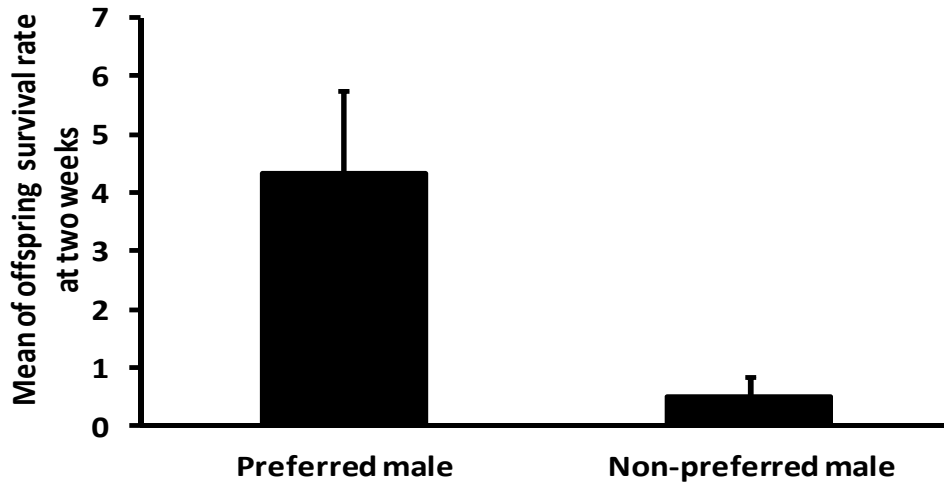


Figure 6. Preferred and non-preferred male of offspring survival rate mean (\pm SE) at two weeks old.

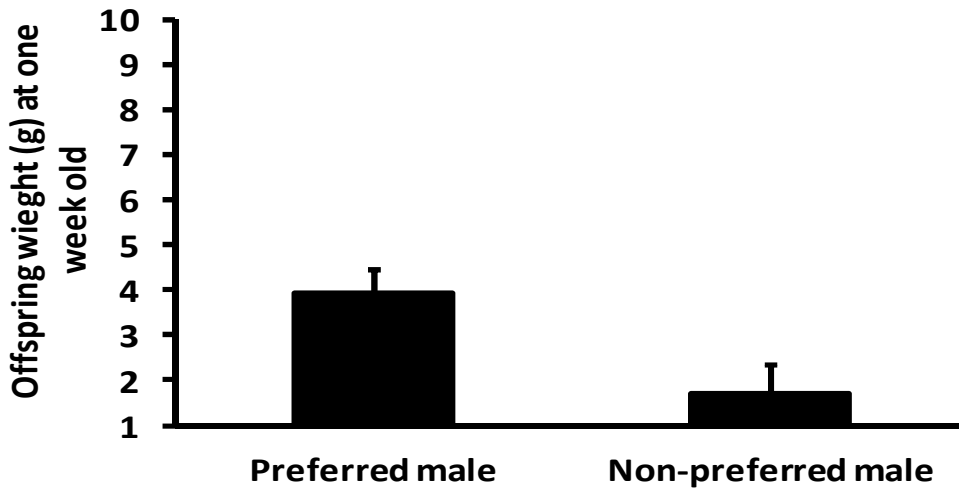


Figure 7. Preferred and non-preferred male of offspring weight(g) mean (\pm SE) at one week old.

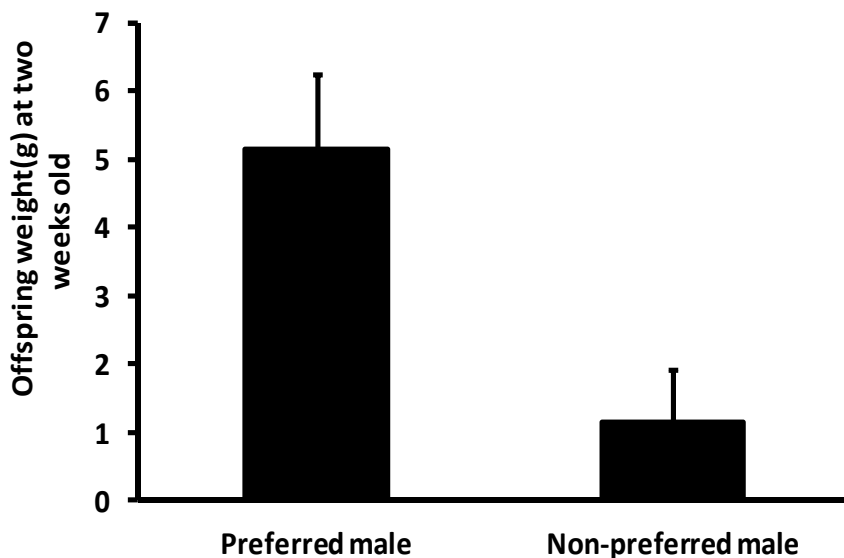


Figure 8. Preferred and non-preferred male of offspring weight(g) mean (\pm SE) at two week old.

Table.1. The interaction effect between preference trait and male chamber on female visiting rate and female visiting duration.

Source	df	SS	MS	F	P
Female visiting rate					
Male Preference (P)	1	40.3333	40.3333	9.31	0.014
Male chamber (C)	1	0.3333	0.3333	0.08	0.788
P X C	1	3.0000	3.0000	0.67	0.438
Error	9	39.00	4.000		
Female visiting duration					
Male Preference (P)	1	4144.08	4144.08	6.99	0.027
Male chamber (C)	1	154.08	154.08	0.26	0.622
P X C	1	18.75	18.75	0.03	0.871
Error	9	5334.75	592.75		

DISCUSSION

In the present study, females have a preference for certain males, but their preference are inconsistent, which possibly suggest non-additive genetic advantages in female mate selection. Remarkably, offspring sired by chosen males had a higher survival rate to independence and also a slightly higher weight, indicating that female mate preference has a fitness advantage. Only a few studies have substantial evidence for additive benefits of female mate preference such as, three-spined stickleback fish *Gasterosteus aculeatus* (Barber et al. 2001), and gray tree frog *Hyla versicolor* (Welch et al. 1998). It is possible that the outcomes of this study support the role of genetic compatibility in the mating system of mice that has been proposed in some studies. Oestrous female mice *M. musculus* tend to mate with major histocompatibility complex (MHC) dissimilar males (Egid and Brown 1989, Potts et al. 1991), human females also showed a variation in the preference for MHC mates (Jordan and Bruford 1998). According to (Zeh and Zeh 1996), a genetic incompatibilities between potential mates resulting from intragenomic conflict and may significantly reduce fertilization rate and offspring viability, resulting in heavy preference for mate choice based on compatibility. Complex associations between male and female genotypes over multiple genes may impose extreme limits on such mating system therefore, genetic compatibility is likely to be restricted to certain genetic structures in order to serve as the basis for a mate choice system (Puurтинен et al. 2005). The genes of the MHC are one such genetic system, and mate preference by selecting MHC dissimilar partners, would help to increase MHC variability in the offspring, representing a non-additive advantage of mate choice (Tregenza and Wedell 2000, Jordan and Bruford 1998). The paradigm of genetic compatibility also raises conceptual problems as to how it works, the functional foundation for compatibility is uncertain, but may be linked with benefit connected with improved heterozygosity and inbreeding avoidance (Brown and Eklund 1994). The mechanism depends on female recognition of its own genotype or at least parts of her genotype, as well as those of prospective mates in making mate choice choices (Tregenza and Wedell 2000). However it is poorly understood how a female can match her genotype to that of a compatible male in order to be able to operate as the basis for a mate choice system (Puurтинен et al. 2005).

In conclusion, in mating system of albino mice *Mus musculus*, females were choosy about partner who mate with. It was also revealed that female mate choice correspond with high fitness of offspring in terms of offspring survival and body weight. It is hypothesized non-additive genetic advantages play a major role and genetic compatibility is the process by which females benefit from mate choice, and male MHC dissimilarity signals genetic compatibility, which is most likely sensed by odour cues. However, further researches are needed to fully understand the consequences of mate preference on offspring quality and the mechanism that female may use in mate choice.

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