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Evaluating the efficiency and house mice response to Faragir and snap traps in Mashhad, Iran

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The house mouse (*Mus musculus*) is a small mammal of the order Rodentia. In general, this species inflicts many direct and indirect economic losses and public health problems. Mainly economic losses are the damage to building installations, building structures, and stored products, poultry farms. Trapping is an effective and often used common method of controlling mice. To decrease the use of poison baits and environmental protection, controlling mice by traps is very important. In this study, the efficiency of Faragir trap (multicatch live trap) compared to the snap trap (single capture dead trap) in controlling house mice in Mashhad were evaluated. Also mice trapping pattern and mice response to Faragir trap were assessed. In trapping period, peanut baits were replaced in all traps, 40 Faragir traps and 40 snap traps were set for five consecutive nights in poultry farm, agricultural farm field and building. Faragir traps were also visited daily; number of captured mice was recorded and the captured mice were retained inside traps until the end of trapping period. To reduce experimental error; the places of traps were not changed during this study and after trapping in each place, all traps were washed with hot water and maintained in fresh air for three days, so that the smell of previously captured mice goes away. The factorial analysis of variance on trap efficiency against *Mus musculus* indicated that the main effects of trap type, place and trapping nights and the interaction of place × trapping nights were significant, but the interaction of the trap type × place and trapping nights × trap type were not significant. However, trap success against *Mus musculus* for Faragir and snap traps, were achieved 35.5 and 18.5% respectively. Generally, both of traps were more effective indoor compared to outdoor in mice control.

Key words: *Mus musculus, trap efficiency, control, Faragir trap.*

INTRODUCTION

adaptability and behavioral flexibility in many habitats in the world (Castillo *et al.*, 2003; Gomez *et al.*, 2008). In general, this species inflict many direct and indirect economic losses and public health problems (Ranjan & Mathur, 1982; Meerburg *et al.*, 2004; Carver *et al.*, 2008). Mainly economic losses are the damage to building installations, building structures, and stored products, poultry farms, human's furniture (Parshad *et al.*, 1987; Castillo *et al.*, 2003). As well as house mouse can be found in agricultural fields that cause damage to plants (Gomez *et al.*, 2008). Usually, the damage of commensal house mice to indoor area more than agricultural fields, and controlling them is more important. In relation to public health, house mice act as the infection agents of some disease namely the reservoir of lymphocytic choriomeningitis virus and the etiologic agents of lymphocytic choriomeningitis (Pai *et al.*, 2003; Gomez *et al.*, 2008). Commensal rodents like *Mus musculus* play an important role in the transmission of diseases to humans among the rodents in Iran. In short, almost 14 diseases have been reported from house mice in Iran (Rabiee *et al.*, 2018) including Salmonellosis, Leptospirosis in Khorasan province, Tuberculosis, Bartonellosis, hemorrhagic fever

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Cryptosporidiosis, Leishmaniasis, Hepatic Capillariasis, Hymenolepiasis (Rodentolepiasis), Taeniasis, *Echinococcus Multilocularis* (Khorasan), Moniliformiasis, Trichuriasis, Babesiosis. The behavior of commensal populations of *M. musculus* is different from non-commensal populations, as a result it is expected that their response to traps be different, too (Frynta *et al.*, 2005).

Traps and poison baits are the most commonly methods that used for house mice control (Hasanuzzaman *et al.*, 2009; Morzillo & Mertig, 2011). In general, for some reasons such as the hazardous effects of poison baits to human and the environment, bait shyness, bait resistance, trapping of house mice is often preferable (Singleton *et al.*, 1999; Smith & Meyer, 2015). Importantly, trapping in comparison to poison baits will allow to physically removing the carcass, thereby eliminating odor problems that occur because of the composition (Hutchins *et al.*, 2003b). There are several main types of rodent trap: snap traps, multicatch traps and single catch live traps. Snap traps are the most used traps in the house mice control (Witmer *et al.*, 2003). Some studies demonstrated multicatch traps have more efficiency than snap traps in capturing rodent (Parshad *et al.*, 1987; Drickamer & Springer, 1998; Ylonen *et al.*, 2003). Some advantages of multicatch traps are the ability to capture several rats or mice with one setting, the scent from captured rodents entices others to trap (Gurnell & Little, 1992; Tobin *et al.*, 1993; Proulx, 2004) (Hamidi, 2015). Trap efficiency for house mice is very variable and depends on many factors, mainly bait types, trap types, environmental conditions such as quantity and quality of food available, trapping time and place, population densities, social interaction (Ylonen H. *et al.*, 2003) . In many states, for the trap shyness or neophobia of house mice, trapping has not desired results (Parshad *et al.*, 1987; Drickamer & Springer, 1998). Usually, poison baits are used more than traps in house mice control, in Iran (Taghizadeh *et al.*, 2006). To decrease the use of poison baits and environmental protection, controlling mice by traps is very important (Meerburg *et al.*, 2004; Morzillo & Mertig, 2011). In this study, we evaluated the efficiency of Faragir trap compared to snap trap in controlling house mice in the indoor and outdoor places. In addition, we investigated differences of the mice response to multicatch live trap and single capture dead trap.

FIGURE 1. A: Faragir traps, B: snap trap.

MATERIAL AND METHODS

Faragir and snap traps (40 of each) were purchased from Asa Gostaran Faragir Company. Snap trap is a single kill trap made from galvanized iron with the dimension of 10×20 cm. (Fig 1). Faragir trap is a multicatch live trap made of Acrylonitrile butadiene styrene (ABS) chewing-resistant with galvanized wire fencing in some sides of the trap with the dimension of 25×7×7 cm. The multicatch trap used in this study was a slight modification of the Faragir trap which has been patented in Iran (number: 68186). The rodents enter to the trap through an entrance in which their weight triggers a treadle allowing them access to food bait. The treadle is counter-weighted so that it closes immediately after passing the rodent, preventing the rodent escape. The peanut is used as bait in traps.

Trapping were conducted in the city of Mashhad (59° 15' to 60° 36' longitude and 35°43' to 37° 8' latitude, with 979 elevations) Khorasan Razavi Province, on northeast of Iran. Also, poultry farm and building were selected as indoor places and agricultural farm as outdoor. In each place, 40 Faragir traps and 40 snap traps were set for five consecutive nights. Usually, traps set near the holes, shelter, nest and mice activity places with 3m interval. In trapping period, peanut baits were replaced in all traps and sprung or captured snap traps were reset daily. Faragir traps were also visited daily; number of captured mice was recorded and the captured mice were retained inside traps until the end of trapping period. To reduce experimental error; the places of traps were not changed during this study and after trapping in each place, all traps were washed with hot water and maintained in fresh air for 3 days, so that the smell of previously captured mice goes away. Trap success were evaluated by Nelson and Clark formula (1973) (Nelson & Clark, 1973):

$$\text{The number of captures} / (\text{number of traps} \times \text{number of nights}) \times 100$$

The analysis of variance was performed on trap success data to detect the effect of places, and trap types. The analysis of variance was performed on trap success data to detect the effect of places, and trap types. We used the normality test to analyze of the data. The analysis of variance was done in the form of a general linear model on logarithmic data. Mean comparisons were done using Tukey HSD (Tukey's Honestly Significant Difference) test. Furthermore, two-way analysis of variance was done to compare trap types with regards to the number of captures in five consecutive trapping nights as factors. All analyses were conducted using the software Minitab 17 with the confidence interval of 0.05.

RESULTS

Trap efficiency

The factorial analysis of variance on trap efficiency against *M. musculus* indicated that the main effects of trap type ($F_{(1,20)} = 11.35$, P=0.003), place ($F_{(2,20)} = 22.96$, P<0.001), and trapping nights ($F_{(4,20)} = 14.71$, P<0.001) were significant. The interaction effects of place × trap type ($F_{(2,20)} = 1.41$, P=0.267) were not significant, but they were significant in poultry farm and building (indoor places), and not significant in agricultural farm (outdoor place) (Fig 2). However, more trap success against *M. musculus* were obtained for Faragir trap (35.5%) compared to snap trap (18.5%) (Table 1). Using pooled data in different place, the results showed that in both Faragir and snap traps, maximum trap success achieved in building and minimum in the agricultural farm (Table). Totally, mean number of mice captured in one trap for Faragir and snap trap were calculated respectively 1/77 and 0/92 (Table 1).

Table 1. Faragir and snap trap efficiency on *Mus musculus* in different places

Trap type	Place											
	Poultry farm				building				Agricultural farm			
	Trap night	Number of Captured mice	Trap success (%)	Mea*	Trap night	Number of Captured mice	Trap success (%)	Mean*	Trap night	Number of Captured mice	Trap success (%)	Mean*
Faragir	200	81	40.5	2.025	200	104	52	2.6	200	28	14	0.7
Snap	200	32	16	0.8	200	59	29.5	1.47	200	20	10	0.5

*mean number of mice captured in the total of 40 traps.

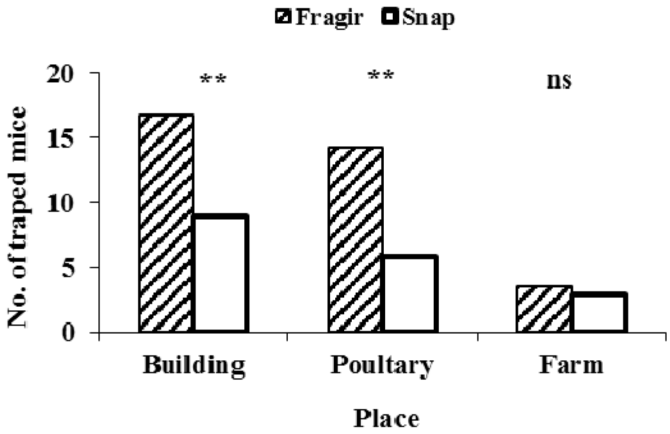

FIGURE 2. Comparing the effects of trap type × place in the indoor and outdoor places

Mice trapping pattern

The results showed that in Faragir trap, maximum numbers of mice were captured during the second night and in snap traps, except in poultry farm, more mice were captured during the first night (Fig 1). Only in the agricultural farm on the first night the number of mice captured in the snap traps were more than in the Faragir traps. However, the results indicated that the main effect of trapping night ($F_{(4,8)} = 39.06$, $P < 0.001$), trap type ($F_{(1,8)} = 30.13$, $P = 0.001$) and place ($F_{(2,8)} = 60.98$, $P < 0.001$) was significant but The interaction effects of trap type × trapping nights ($F_{(4,8)} = 1.99$, $P > 0.189$) and place× trap type ($F_{(2,8)} = 3.75$, $P = 0.071$) were not significant, but they were significant in the poultry farm and building, and not significant in agricultural farm. The interaction effects of places × trapping nights ($F_{(8, 8)} = 4.64$, $P > 0.022$) were significant (Fig 3).

Mice response to Faragir trap

The highest number of mice in one Faragir trap in agricultural farm, building and poultry farm, were observed three, seven, eight, respectively (Fig. 4). The results demonstrated that 60, 30 and 22.5% of Faragir traps in agricultural farm, poultry farm and building, did not catch any mice in trapping period. In our study, some mice died in Faragir traps, but the others were attracted to the same traps in trapping period. Between Faragir traps with mice captured, 62.5, 82.4 and 90.32% of traps in agricultural farm, poultry farm and building captured more than one mice, respectively.

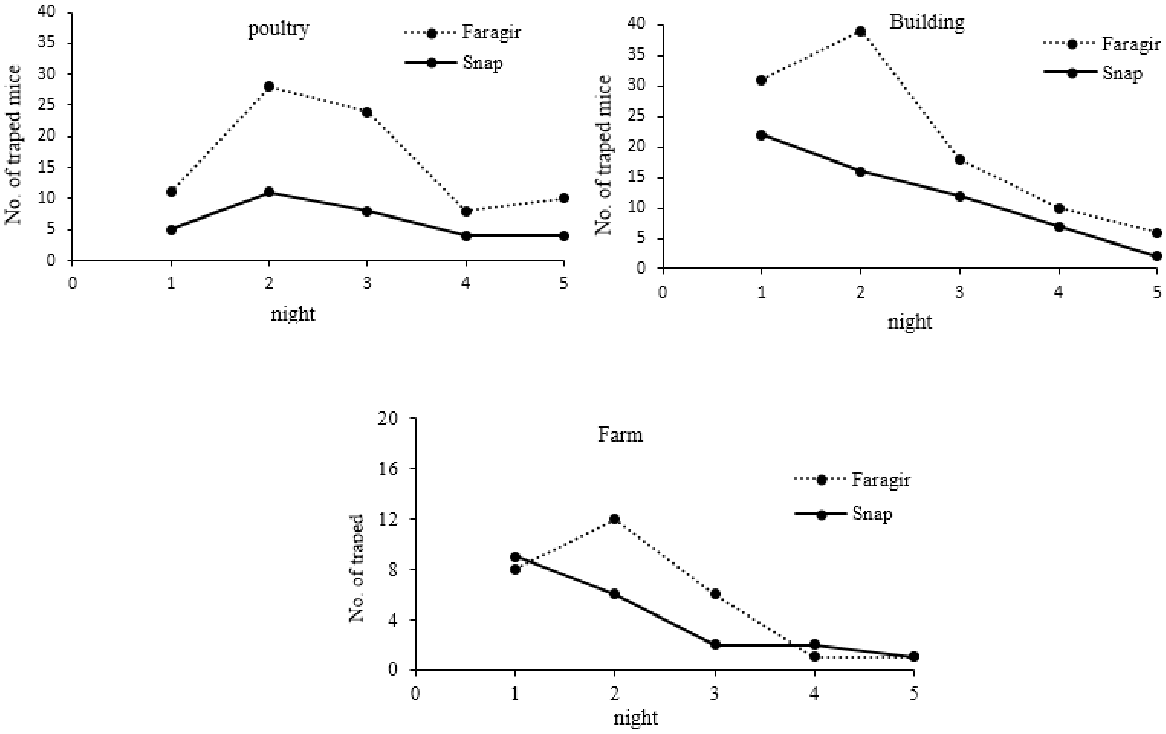

FIGURE 3. A comparison between the numbers of *Mus musculus* captured in traps during trapping nights in in the three places.

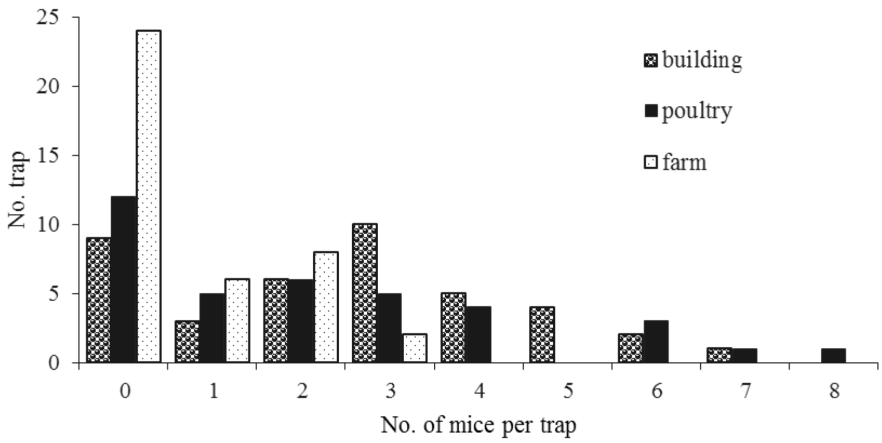

FIGURE 4. Number of *Mus musculus* captured in each Faragir traps in trapping period for places.

DISSCUSSION

Trap efficiency

Mus musculus has a has a worldwide distribution and it is found in many different habitats (Caut *et al.*, 2007; Witmer *et al.*, 2007). it is controlled by poisoning, fumigation, trapping and repellents (MacKay *et al.*, 2007). Some studies indicated trapping in some conditions, can be an effective method of rodent control (Gebauer *et al.*, 1992; Tobin *et al.*, 1993; Ahmed *et al.*, 1995; Gomez *et al.*, 2008) Rodent trap efficiency varied depending on various factors including bait type (Lee, 1997), trap type (Leso & Keropil, 2010), food composition (Clapperton, 2006), species (Keronenberger & Midioni, 1980), and specific-rodent traits such as population density, social interactions, feeding behavior and habitat (Oswald & Flake, 1994; Santos-Filho *et al.*, 2006; Theuerkauf *et al.*, 2011). Researchers showed that for each rodent species there is bait preference based on its feeding behavior (Hutchins *et al.*, 2003a). In the present study, we did not check out the effect of bait on trap success, maybe use of other baits would increase the trap efficiency. Our results indicated that Faragir trap was more efficient than snap trap and trapping indoor was more effective than outdoor places. Similarly, Belmain (2003) demonstrated that efficiency of multi captured trap in rats control was generally more than single captured trap (Belmain *et al.*, 2003). In contrast, Ylonen *et al.* (2003) showed that for some rodent species including *Gerbillus dasyurus*, *G. andersoni allenbyi, G. henleyi* and *Meriones crassus*, multicatch capture trap was less efficient than single capture trap. Hamidi (2015) represented that multicatch trap is more effective and need less labor than singlecatch traps (Hamidi, 2015). Odor plays a major role in the regulation of mammalian social behavior (Johnston, 2003). Many investigations have shown that in multicatch trap, the scent from earlier captured rodents entices more rodents to be trapped thereafter (Daly *et al.*, 1980). However, rodent attraction to multicatch traps or trap residual odor is dependent on sex (Gurnell & Little, 1992), age (Proulx, 2004), reproductive state (Tobin & Sugihara, 1994), social status (dominant or subordinate) and kin and species relations of the first captured rodent (Johnston, 2003). Lee (1997) demonstrated live capture trap is more effective than snap trap. One reason is the carcass of mice captured in snap trap that cause by other mice coming trap shyness (Lee, 1997). In both types of traps, trap efficiency were more investigated in the building and poultry farm rather than agricultural farm. This result showed the effect of the place and food supply on mice behavior and trap efficiency was more investigated (Hansson, 1992; Lidicker Jr. & Stenseth, 1992) (Tann *et al.*, 1991; Pech *et al.*, 1999). In addition, due to more human activity in building and poultry farm, mice are less sensitive to environmental changes and new things that cause to reduction of trap shyness and neophobia (Kirkland & Fleming, 1990).

Mice trapping pattern

Some authors have demonstrated that the first three nights of trapping period showed the highest capturing rate and that it was the most in the second night (Parshad *et al.*, 1987; Weihong *et al.*, 1999; Ylonen *et al.*, 2003). Similarly, in our study, maximum rate captures occurred in the second night with Faragir trap (Fig. 1). The highest number of mice was captured in the snap trap on the first night, except to poultry farm, and in Faragir trap on the second night. Presumably, in Faragir traps the captured mice attracted other mice and affected on decreasing trap shyness. Daly *et al.* (1980) indicated the scent from earlier captured rodents entices more rodents to be trapped thereafter (Daly *et al.*, 1980). On the other hand, there was a delay between the nights with the highest capturing rate in both traps. Predictably, Faragir trap had a different mechanism and was bigger in size than snap tap, hence maybe it has affected on mice neophobia and caused the delay in the time of maximum trapping (Astúa1 *et al.*, 2006). Furthermore, in trapping night, the capturing rate decreased in both traps (Fig. 1). This may suggest that the density of *Mus musculus* decreased in the area with more capturing (Parshad *et al.*, 1987; Gurnell & Little, 1992).

Mice response to Faragir trap

Some studies introduced that house mice have excellent vision, hearing and sense of smell. They use pheromones and other smells to communicate with each other about social dominance, family composition, and reproductive readiness (Proulx, 2004) (Timothy & Zhongsheng, 2005). Our results confirm that the presence of mice in the trap affected on the neophobia and trap shyness of the other mice, (Drickamer & Springer, 1998). (Pawlina & Proulx, 1999). Rodents have strong chemical communications with each other using odors and signals in urine, feces, vaginal secretions, saliva and body glands (Johnston, 2003). Researchers showed that there has been tendency for recaptures to occur in traps containing residual odor of a conspecific (Daly *et al.*, 1980; Gurnell & Little, 1992). Also we observed that the house mice were more attracted to Faragir traps with mice (live or dead) in them than to the others with no captured ones.

Our results indicated that Faragir traps were more efficient than snap traps in house mice control and the scent from earlier captured mice attracted other mice to be trapped. Also, trapping indoor like building and poultry farm was more effective than outdoor places like agricultural farm. In this study, we did not investigate the sex and age of captured mice into Faragir traps, therefore checking out these factors may increase our knowledge about mice behaviors and social interactions. The results can modify the trap efficiency in mice control. Also our results have not shown that captured mice how much affected on reduction of neophobia and trap shyness of other mice; accordingly, we suggested this hypothesis to be tested.

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