Effects of Vertical Panel on the Behavior of Thai Native Chicken Hens Paired with Cocks Kept in Bamboo Chicken Coops

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ABSTRACT

The incidence of over-mating and injuries by female are inevitable and vital welfare problem in mixed-sex chicken flocks. The experiment aimed to reduce the rate of sexual aggression in fighting cocks paired with hens in bamboo coop. The chickens were housed as mixed-sex pairs in 150 cm diameter, 124 cm height, bamboo coops provided with a wood perch in semi-open barn. Rice seeds were mixed with sand and wood shaving used as litter materials. Sixteen mature chickens (8 cocks, 8 hens) served as subjects. The experiment was conducted over two, four week periods. During the first period, coops containing no cover served as control. In the second period, coop was provided with a vertical panel. The panel constructed of bamboo and polypropylene fluted board was positioned 20 cm away from the center of coop. The behavior of each hen was recorded between 06.00 and 18.00 h using scan and behavior sampling methods. Hens allocated a large proportion of their time to resting activities, accounting for over 25% of the chicken time-budget. Aggression and mating behavior occurred less frequently in coops with vertical panel ($P < 0.05$). Ground scratching and dust-bathing bout were significantly increased ($P < 0.05$) when the vertical panel was provided. Overall, the presence of vertical panel allows hens to perform more natural behaviors (e.g. ground scratching, and dust-bathing) but reduced harmful interactions. This result indicates that vertical panel can control a severe over-mating problem in the bamboo chicken coop. This finding may be interpreted as the improvement of chicken welfare under the condition of restricted space.

Keywords: Vertical panel, aggression, behavior, animal welfare, Thai native chicken

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INTRODUCTION

Thai native chickens are the most popular farm animal in Thailand with an estimate at least 10 million individuals being kept as sport animals or fighting cocks (Somparn and Lumphuttha, 2017). Every day, millions of fighting cocks are housed singly in small, barren bamboo coops in which they are unable to perform most of their natural behaviors. The behavior of cooped Thai native chickens (fighting cocks) is rarely reported and made public, presumably to avoid societal pressure against cruelty to animals. Somparn and Chelermsilp (2014) observed that fighting cocks kept individually in the conventional round, bamboo coops (80–cm diameter at the base) spent the majority of their time inactive (70% of daytime). Whereas their counterparts kept in flock under semi-natural conditions were inactive only 33% of daytime (Somparn *et al*., 2016). Consequently, providing a limited space in bamboo coop may lead to invoking a high level of stress for captive chickens potentially.

The concept of natural behavior is a key element in current global policy-making on animal

welfare. More complex environments which give the individual more control and hence result in an elaboration of a number of natural behaviors are now being provided in good animal accommodation. The use of enrichment is one element of routine husbandry in livestock productions. Enrichment can be viewed as any modification of the environment that exerts favorable effects on the animals' behavior and ability to cope with captivity by stimulating their species-specific needs (Newberry, 1995). For social species there can be no doubt that the presence of conspecifics acts as an important enrichment. Because conspecifics offer interactions that are unpredictable and novel allow more opportunities for exploration. A social companion might buffer the effects of a stressful situation, reduce behavioral abnormality, increase opportunities to exercise, and expand species-specific behavior and cognitive stimulation (NRC, 1996; Rees, 2011). Previous study in our Thai native chicken flocks showed that compared with lone cocks, cocks paired with hens performed a wider variety of behaviors and social interactions. The presence of a female partner can persuade cock to perform more natural behaviors. Inevitably, the incidence of injuries and over mating (> 1 time per day) also occurred (Somparn and Lumphuttha, 2017). In multi-male groups, female fowls are routinely subjected to forced copulation attempts by subordinate males. Usually females run away from such advances (Birkhead and Pizzari, 2009). Under minimal, barren conditions, in bamboo coops there is no opportunity to escape so forced inseminations can escalate rapidly, resulting in injury to female.

Cover availability is essential feature of natural environments, offering protection from adverse weather conditions, predators as well as aggressive conspecifics. In captive environments, it is important that we provide opportunities for animals to avoid contact with other group members if they so desire (Young, 2003). Aggression does adversely affect the welfare of the individual, which is the target of aggression (Broom and Johnson, 1993). The presence of artificial cover has been found to reduce the frequency of aggression and chases in several species including mammals (Erwin *et al*., 1976; McGlone and Curtis, 1985) and birds (Cornetto *et al*., 2002; Deeming *et al*., 2011). When applied to broiler breeders, cover panels were able to control a severe over-mating problem in a commercial facility (Estevez, 1999). The incidence of over-mating and injuries by the female is critical welfare problem in mixed-sex chicken flocks. We hypothesized that providing artificial cover in enriched bamboo coops would reduce the rate of sexual aggression between cocks and hens.

MATERIALS AND METHODS

Animals and Management

The experiment was conducted at the Thammasat University (Rangsit campus), Pathumthani province, Thailand. Due to breeding season of red jungle fowl in Thailand starting in December and lasting until May (Wanghongsa and Hayashi, 2010), then this study was carried out between March and April 2016. Sixteen 10–to 12–month-old Thai native chickens (8 cocks, 8 hens) were obtained from local native chicken farms in Klong Luang district, Pathumthani province. Birds were fed a commercial native chicken diet (JBF Co., Ltd., Thailand) consisting of 2,800 kcal/kg ME and 20% protein. To control body weight, all animals received 80% of their feed intake, which average 100 g per animal per day. The calculation of feed restriction was based on total feed intake for each bird one week before the start of the experiment.

The chickens were housed as mixed-sex pairs in 150 cm diameter at the base, 124 cm height, bamboo coops provided with a 4 cm diameter round wooden perch (45 cm above the floor and 50 cm from the center of the coop). All of these enriched coops were positioned in a semi-open barn. The ten cm-deep mixture of sand and wood-shaving was used as litter materials. Once every three days, 200 g of rice seeds were added and mixed with litter materials to stimulate foraging behavior. The experiment was conducted over two, four-week periods. During the first period, coop containing no cover served as control. In the second period, coop was provided with vertical panels that served as cover treatment.

The panel frames (124 cm high × 65 cm wide) was constructed from 3 cm diameter bamboo pole which its top-end attached to the ceiling of the coop. The panel stood in a vertically fashion, perpendicular to the floor. It was held 20 cm away from the center of the coop. A 53 × 65 cm piece of black polypropylene fluted board was attached to a panel frame (Figure 1). Nylon bird net was also provided in order to avoid predatory or nuisance birds. Routine work such as cleaning the coops, collecting eggs, health checking of chickens, replenishment of feed and water were performed at 07:00 h and 17:00 h. Fresh wood-shaving being added on top as needed. Two 7.5 × 11 × 6 cm semi-round feeders and two 7.5 × 11 × 6 cm semi-round drinkers installed on sidewall of the coop (28 cm above the floor). There was a distance of 20 cm between a feeder and a drinker. The remainders mounted on the opposite side of the coop's sidewall at the same height and distance apart (Figure 1).

All applicable national and institutional guidelines and guidelines for the ethical use of animals in applied animal behavior research (Sherwin *et al*., 2003) were followed.

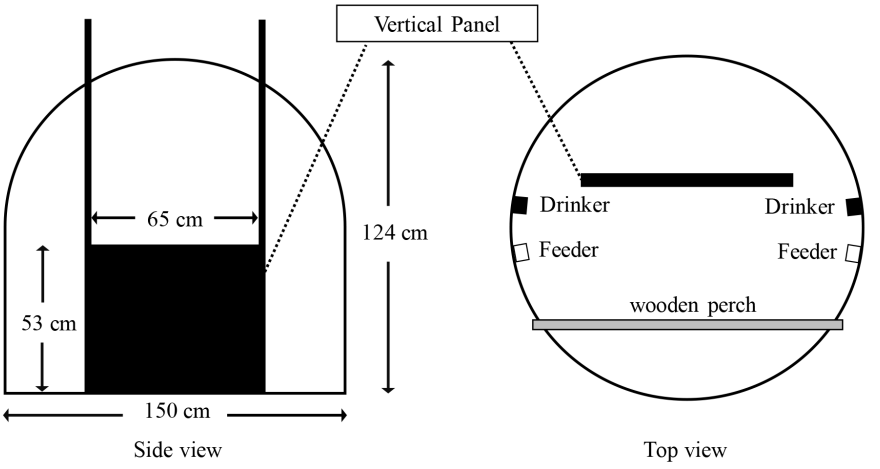

Figure 1 Schematic diagram of a bamboo coop with vertical panel (figure not to scale)

Data Collection and Analysis

On day 7, 14, 21 and 28 of each period, the behavior of each hen was recorded by two trained observers between 06:00 and 18:00 h using instantaneous scan sampling with a 1–min interval and behavior sampling methods (Martin and Bateson, 2007). The behaviors observed, according to each observational methodology, are summarized in Table 1. For analysis, the individual hen was considered as an experimental unit. Incidents of dustbathing, perching, mating and male-to-hen aggression were summed over the day, and daily sums were averaged over a 4–day observation period. For the analyses of the other behaviors, daily sums were averaged over a 4–day observation period. Normality was verified for all continuous variables using histograms, normal probability plot, and Shapiro-Wilk tests using the UNIVARIATE procedure (SAS, 1985). Non-normal data were analyzed using Wilcoxon matched-pairs signed-rank test. The effect of the vertical panel on the behavioral time budget was performed by paired *t*-tests. For some behaviors, i.e. the number of dustbathing bouts, mating and male-to-hen aggression, the Wilcoxon matched-pairs signed-rank test was used to determine the differences between coop with or without vertical panel. Differences between means were considered statistically significant when $P < 0.05$. A tendency was established between $P > 0.05$ and $P < 0.1$. All means are presented ± standard deviation.

Table 1 Ethogram used for both scan and behavior sampling

Recorded behavior	Definition
Scan sampling	
Eating	Hen place its head inside a feeder
Ground pecking	Hen pecks at items (visible or not) on ground (Eklund and Jensen, 2011)
Ground scratching	The body bending forward, the bird makes a backward stroke with one leg. Usually one to four strokes with one leg are followed by one to four strokes with the other (Blokhuis, 1989)
Drinking	Hen drinks in the drinker
Locomotion	Walking, running, jumping or flying
Preening	Hen directs its beak to its own plumage of several body parts and carries out pecking, nibbling, combing or rotating movements, once or repeatedly (Pickel *et al*., 2010)
Resting	Hens sit or stand on the ground, perch or vertical panel, including dustbathing
Behavior sampling	
Dust bathing	Hen lies down and pulls loose substrate close to its body to toss it and distribute above its body with a series of legs and wing movements (Rodriguez-Aurrekoetxea *et al*., 2015)
Perching	Hen sits or stands on the perch or the top of vertical panel
Male-to-hen aggression	Aggressive attacks to the head or body of a hen in such a way as not to be associated with an attempted mating or when the male attack the hen in aggressive way and try to force the female into mating (Moyle *et al*., 2010)
Mating	The male mount, grip, and tread a female and appear to achieve cloacal contact. The female ruffle her feathers following the male's dismount (Millman *et al*., 2000)

RESULTS AND DISCUSSION

The results of the behavioral observations of hens in enriched bamboo coops between sunrise and sunset are shown in Table 2. These data are reported as total time spent and the number of selected incident in each activity. Hens devoted a large proportion of their time to resting accounting over 25% of the daytime. Ground pecking and ground scratching are common components of foraging behavior for chickens and other galliforms. Overall, in this present study, hens kept in an enriched bamboo coop, both with and without vertical panel, performed foraging behavior ranging from 21 to 54% of daylight hour. These results consistent with our previous observations in similar conditions, where cock paired with hen, spent about 41% of daytime in foraging behavior (Somparn and Lumphuttha, 2017). Foraging behavior in chicken occupies considerable proportion of the day and is performed for approximately 60% of daylight hours by semi-wild red jungle fowls (Dawkins, 1989). In contrast, this proportion of time can be much shorter under commercial housing systems. For example, laying hens kept in deep litter house spent 5 to 25% of daytime engaged in foraging

behavior (Appleby *et al.*, 1989). Moreover, in Thai Native chicken, Somparn and Chalermsilp (2014) found that fighting cock kept alone under barren, conventional bamboo coop spent under 3% of their time foraging. This result indicated that hen kept in coop with artificial cover was still able to perform more species-specific behaviors similar to their semi-natural raised counterparts (Somparn *et al*., 2016).

Table 2 Mean time and number of incidents spent in various activities by Thai native hens paired with cocks confined in enriched bamboo coops with or without vertical panel

Behavior	Housing condition		P-value
	Control	Vertical panel	
General behavior (min per 12 h)			
Eating	35.69 ± 3.94	25.88 ± 3.34	0.001
Ground pecking	165.88 ± 20.06	183.81 ± 37.12	0.267
Ground scratching	35.37 ± 5.54	81.88 ± 12.63	<0.001
Resting	234.37 ± 36.96	213.75 ± 36.64	0.317
Locomotion	133.66 ± 24.29	117.12 ± 10.83	0.051
Drinking	30.12 ± 7.60	14.34 ± 3.98	0.002
Comfort behavior (min per 12 h)			
Preening	84.91 ± 20.19	83.22 ± 21.09	0.742
Dust bathing *	17.82 ± 8.89	29.34 ± 8.59	0.063
Number of bout * (per 12 h)	1.90 ± 0.67	3.30 ± 0.76	0.012
Perching *	82.00 ± 14.85	64.54 ± 8.76	0.020
Social behavior (bout per 12 h)			
Mating *	3.62 ± 1.57	1.16 ± 0.57	0.008
Male-to-hen aggression *	6.94 ± 1.11	1.59 ± 0.88	<0.001

Note: * Variables measured using behavior sampling method

When the vertical panel was provided, mating frequency reduced from about four to one time per day on average ($P < 0.01$). There was considerable individual variation ranges between 0 and 7 time per day. This result is, generally similar to the finding of Wilson and Evans (2008, personal communication) for golden Sebright males which mated an average 2.5 time per day, ranging from 0 and 11 time per day. In this study, we did not determine fertility. However, these frequencies are still higher than necessary because fertility is just as high even though mating is performed less often, due to the ability of hens to store viable sperm of their pairs. Unlike most mammals, chicken sperm are probably stored within oviduct sperm storage tubule located at the uterovaginal junction up to 32 days after copulation or artificial insemination (Bakst and Bahr, 1993).

In the present study, cock frequently attempted to copulate hen during late afternoon period (Figure 2a). Add to this the energetic demands of egg-laying, and it is reasonable to suppose the fatigue and exhaustion may play a part reduce female receptivity to the point where mating can be achieved only through aggression (Nicol, 2015). Aggression was observed more often in coops with no vertical panel ($P < 0.01$). These findings uphold results obtained from previous research where the presence of vertical panel reduced inter-animal interaction in chicken (Estevez *et al*., 1998). Interestingly, the peak of mating and aggression behavior in coop with vertical panel had a lower magnitude compared to coop without vertical panel (Figure 2a and 2b). As expected, the peak in mating behavior coincided with the peak in aggression behavior which occurred during the afternoon period. The coincidence in trends between mating and aggression behavior suggested that mating was in the most cases not preceded by voluntarily crouching of hen. The cocks tended to hurt hens during mating which involve pecking, scratching, trampling as well as kicking. It also found that hens often had severe lacerations on the back of the head and along the torso, beneath the wings. This result is similar to the study of Millman *et al*. (2000), and it can be concluded that injuries resulted from sexual aggression rather than male-to-female aggression, where injuries would be expected to appear frontally. Kruijt (1964) reported that male jungle fowl responded aggressively towards a female during mating when female tried to escape from the male. Possibly this may partially explain why agonistic interactions of their counterpart occurred more frequently during the afternoon period.

Hen in coop with vertical panel tended to spend more time dustbathing ($P < 0.10$) and spent more time ground scratching ($P < 0.01$) but spent less time eating ($P < 0.01$) and perching ($P < 0.05$). When kept in coop with a vertical panel, hen also dustbathed with a higher frequency ($P < 0.05$) compared to control coop. In general, increasing time spent in one behavior necessarily involves reducing time spent in another. It was observed that food bins were emptied shortly by all pairs after providing them with new food. This result indicated that the decrease of time spent eating is partly associated with the increase of time spent ground scratching. It could be proposed that hens may increase the rate of food intake in order to spend more time in other activities, particularly strongly motivated behaviors, e.g. foraging and comfort behavior. Chickens will sometimes carry out what seen to be unnecessary work: a tendency that called contrafreeloading. This may be associated with a need for control over the environment or a need for information. Foraging such as ground scratching is an essential way of obtaining information to secure future food supplies (Inglis *et al*., 1997), preventing birds from performing it leads to negative emotional state (Vestergaard *et al*., 1997).

When hens kept in coop with a vertical panel, dustbathing showed a precise diurnal rhythm with a marked peak occurred from 13:00 h to 16:00 h (Figure 2c). This finding agrees with those of Orsag *et al*. (2011), who reported a dustbathing maximum between 10:00 h and 16:00 h, and those of Vestergaard (1982) who reported a peak in dustbathing behavior around 6 h after the light had been turned on. In contrast, when kept in coop without vertical panel, hen dustbathed more frequently in the morning. Surprisingly, there was no hen performed dustbathing behavior in the afternoon. Nicol (1989) found a negative correlation between aggression and comfort behaviors. In feral populations of fowl *Gallus gallus domesticus*, male harassment is intense, particularly in the evening when insemination is most likely to result in fertilization (Pizzari *et al*., 2001). In this study, dustbathing behavior appear to be strongly influenced by social context. It would expected to find that when the frequency of agonistic interactions increases, resulting in a decrease in dustbathing behavior by hen paired with cock in enriched coop. This finding may be the reason why hens kept in coop without vertical panel never performed dustbathing behavior in the afternoon at all when sexual harassment was intense.

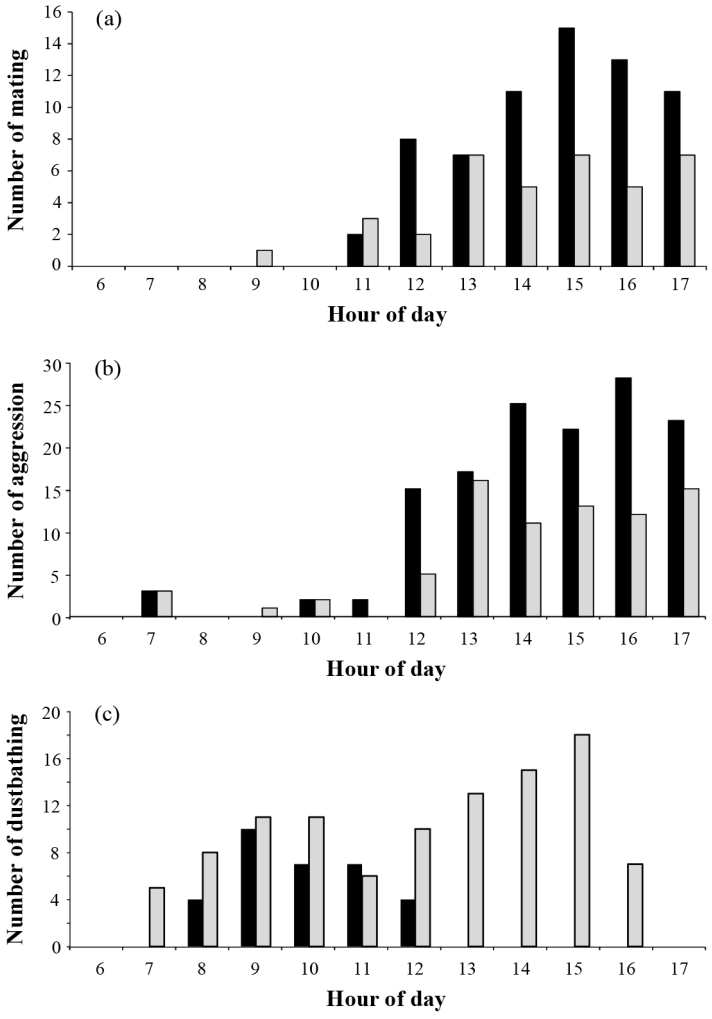

Figure 2 The distribution of (a) mating behavior (b) aggressive interaction and (c) dustbathing behavior by hen paired with cock in coop with (grey bar) or without (black bar) vertical panel throughout the observation periods

Very short and very long dustbathing durations could be observed in both conditions. The shortest dustbathing duration was 2 min, and the longest was 25 min. Compared with the duration of a complete dustbath average between 20 to 30 min in domestic hens (Vestergaard, 1982; Van Liere *et al*., 1990), these observed dustbathing bouts were shorter. This finding confirms the results of other authors, who reported dustbathing durations of 5 to 10 min in enriched housing (Appleby *et al*., 1993; Somparn and Lumphuttha, 2017). Dustbathing appears to be a low-resilience behavior that is forfeited when other needs are more pressing. It has been suggested that chickens allocate time to this behavior as and when the opportunity arises (Windowski and Duncan, 2000). It was observed that dustbathing hen kept in coop without vertical panel is more frequently disturbed by a male during

the study. Vestergaard (1987) reported a common reason for the premature termination of dustbathing behavior was a disruption caused by other conspecific animals. This result indicated that the presence of a vertical panel offers an area in which hen to avoid undesirable interactions with its partner and provide opportunities for hen to perform dustbathing behavior satisfactorily.

On some occasions, we also observed that many hens perched on the top of the vertical panel, where it was the highest enclosure level. Similarly, Newberry *et al*. (2001) found White Leghorn pullets preferred 60 cm perches to 20 cm perches in the daytime. Under natural or semi-natural conditions, during the day perching in elevated locations give chicken a vantage point from which they can monitor their environment (Nicol, 2015). Chickens had a greater sense of security when perching higher off the ground (Keeling *et al*., 1997). Although, domestication has altered behavior quantitatively, qualitatively, domestic fowl continue to exhibit the anti-predator behaviors that evolved in their wild ancestor (Newberry *et al*., 2001). Additionally, elevated structures, i.e. perch or vertical panel, offer birds opportunities to jump on and off them, which hens may have used such structures to avoid mating attempt or aggression by males. According to Akrim *et al*. (2016) the red jungle fowl roosts typically high in a tree, varying from 4 to 8 m above the ground. Perch height preference was adaptive for avoiding ground predators even hens do not expose to predators at all under domestication. This result indicated that vertical panel could reduce the risk of injurious interactions, consequently hen spent more time on the floor. Therefore, further study, which uses vertical panel instead of wooden perch for roosting, will need to be undertaken.

CONCLUSION

Overall, the presence of vertical panel allows hens to perform more natural behaviors (e.g. ground scratching and dust bathing) but reduced aggressive interaction and mating frequency. This results indicated that vertical panels could control a severe over-mating problem in enriched bamboo chicken coops. This finding may be interpreted as the improvement of chicken welfare under the condition of restricted space.

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