Effect of Nest Box Design on Rabbit Does Maternal Behaviour and Production

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Abstract
This study was conducted to compare between three nest box designs and their influence on rabbit does maternal behaviour and production, fifteen adult White New Zealand female rabbits were classified into three groups according to nest box design (A, B and C) and each group contains five females. Among 3 nest box designs, the mean frequency of nursing events increased significantly ($P \leq 0.05$) in group C nest box and flash movement duration (sec.) increased significantly ($P \leq 0.01$) in group B nest box. The mean body weight (g) of kits at 30 days of age decreased significantly ($P \leq 0.01$) in group A nest box. There was no significant difference between the three nest box designs in rabbit does nest quality traits scores before and after parturition and means of prolactin hormone level (ng/ml) at birth and 21 days of age. In light of these results, we could summarize that large or fully opened nest box had a positive effect on nursing events durations (min.), flash movement duration (sec.) and mean body weight (g) of kits at 30 days of age. However, such conditions do not affect other recorded parameters.
Key words: nest box, maternal behaviour, rabbit doe, prolactin

Introduction

Maternal nest building is a complicated process that, in wild and in European rabbits (*Oryctolagus Cuniculus*) occurs at the last part of pregnancy under control of many hormones such as Prolactin hormone ***(González-Mariscal et al., 1994)***. The lactation duration had about 45% of the length of the rabbit's doe lifestyles. Therefore, factors influencing doe performance at some point of lactation will have an effect on pre- and put up-weaning growth, survival of the kits and consequently meat production and income of business farms ***(Bakr et al., 2015)***.

The dimensions of nest field need to be appropriate to the dimensions of rabbit doe ***(González-Redondo, 2006)*** as in Australian wild rabbits, which might be the largest within the global used nest container designs that have been plenty larger ***(Mykytowycz, 1959).*** Then again, the layout of industrial nest boxes used for domesticated rabbit breeds having a median weight of 4-4.5 kg are usually as a minimum 25 × 40 cm at the bottom through 25 to 35 cm in top, with a quantity of as a minimum 30 liters, approximately 4 times that of untamed rabbits' breeding burrows. Also, the usage of open nest bins is common considering that they may be normally positioned in closed environments ***(Lebas et al., 1996).*** In addition, nest containers having a small entrance produce a better number of weaned kits ***Parer et al. (1987).***

Rabbit farming regularly takes place in outdoor centers and therefore nest containers ought to be enclosed receptacles with a view to preserve a steady temperature, at least at some stage in the first weeks of life ***(González-Redondo, 2001).*** Rabbit does might have a nervous temperament in captivity and they'd use the nest box as a shelter whilst alarmed regarded to be calm. Besides that, they conceal inside the nest field to preserve them stress-free and thus reduce the risk of infertility problems ***(González-Redondo, 2003)***.

Nest field layout have a great effect on rabbit does nursing activity. Nursing activity reduced with increasing cage length and the presence of tunnel at the doorway to nest container ***(Selzer et al., 2004).*** Except, the designed nest container with a subway to an internal nest chamber will offer thermal insulation for kits also accepted by a large number of the does for the reason that it is just like their breeding burrows ***González-Redondo (2006).*** The layout may additionally affect the kits life, To protect does' kits from being overwhelmed a few nest container fashions have a resting platform located at once in the entrance, so that the does have no way except to jump before resting her body carefully over youngs to suckle them in the lowered part next to the platform ***Camps (1993).***

Few studies were conducted on nest box designs and its relation to visual communication between rabbit does and its litters so that our aim was to answer this question: Does the continuous vision of young change the expression of maternal behaviour in rabbits?

Materials and Methods

A total of fifteen adult White New Zealand female rabbits were classified into three groups according to nest box design, each group contains five animals. The first design (Group A) which not allows any visual contact between does and their litter, the contact occurred only by entering the nest box through a small rounded hole in the side of the nest box. Its dimensions were 0.28 m × 0.40 m × 0.25 m (length × width × height) and 0.15 m for the whole diameter. The second design (group C) which was the same design as group A, But its dimensions were larger 0.28 m × 0.50 m × 0.30 m (length × width × height) and 0.18 m for the hole diameter. The third design (Group B) which allows a continuous visual contact between does and their litter during the whole day because of there was no any partitions, the nest box was fully opened between does and their litter (Plate 1).

Behavioural measurements

1- Pre-parturient maternal behavioural patterns were recorded in keeping with ***(Denenberg et al., 1958)*** with the aid of each day statement of does behaviour after putting of nest boxes and nesting materials "on day twenty sixth put up-mating" for registering the date of first time of nest constructing and nest lining (NL). For each parameters a score 0 was given whilst the newly born kits have been first found without a nesting substances or no fur protecting (NL) whilst a score 1 was given if the straw nest or the fur were found best when the younger were located. A factor was added to the rating for the two parameters, for each day before parturition.

2- put up-parturient nest quality tendencies had been recorded on the day of parturition in step with ***(Hamilton et al., 1997)*** by means of looking at the nest container for recording these variables: Nest shape (NS), Fur placement (FP), and kit placement (KP) **(**Plate four), which have been scored from 1 to 5 for the primary two variables and from 1 to 4 for the remaining one; the best ratings (5, four) of those variables suggest the quality nest excellent developments while the bottom rating (1) indicate bad nests.

3- Nursing display: The objective of our research was to study nursing-associated events of lactating rabbit does. We focused on nest box visits in the first 2 weeks of lactation of does in the different groups to obtain a better understanding of the nursing behaviour of rabbit does in different designs of nest box. Nursing behaviour of rabbit does was recorded 24 hrs per day during the whole period of the trial. For each doe there is a 144 hrs (6 days) observation period from the beginning of the lighting period on day four of lactation to the end of the dark period on the tenth day ***(Matics et al., 2013)***. In this way, the beginning and the end of observation coincided among groups. Panasonic WV Ns202ae network video cameras were used for observation. The following data were evaluated:

1.Number of nursing events /day.

2.Length of nursing events in (min.).

3.Flash movement frequency.

4.Flash movement duration (Sec.).

A nursing occasion become identified by using of the following standards ***(Petersen et al., 1988):***

a- The length of time that was spent by does over the nest, the puppies, respectively.

b- The nursing position of the doe whilst sitting inside the nest.

c- After nursing, does typically exit the nest speedy, by a soar.

Productive and Reproductive performance (International Rabbit Reproduction Group. IRRG, 2005):

1. Body weight of does (kg) at kindling and at weaning of their litters.
2. Litter size: total born, born alive, stillborn, at 21 and 30 days of age.
3. Kit's weight (g) at birth, 21 and 30 days of age.
4. Total pre-weaning mortality (%).
5. Milk production (kg) was measured by the aid of the regression equation formulated by ***(De Blas et al., 1995)****:*

Milk production (kg) = 0.75 + 1.75 LBW21 (kg)

Where, LBW21 related to live bodyweight of young at 21 days of lactation.

Serum samples collection (Plate 3).

To have a look at the have an effect on of remedies on suggest serum prolactin level, blood samples were gathered from the ear vein of rabbit does into sterilized tubes consistent with the protocol for marginal ear vein blood sample series for rabbits ***(Parasuraman et al., 2010)*****.** This technique was followed for rabbits in which the animal ought to be placed in a stanchion. Ear was cleaned with ninety five% v/v alcohol 10 min before sampling. (We may use a topical vasodilator). Yellow coloration and baby size canula was used to puncture the marginal ear vein and blood was gathered in a gathering tube at 9:00–10:00 a.m. To avoid circadian changes in feed intake ***(Gidenne and Lebas, 2006).*** After a massing blood, clean sterile cotton was saved on the collection site and finger stress was carried out for approximately one minute to prevent the bleeding. The gathered blood samples straight away centrifuged at 2000×g for 10 min. Serum turned into saved at -20 ◦C till analyzed. The blood samples have been accrued at day of parturition and at the 21th day postpartum from rabbit does of the specific groups.

Prolactin hormone level estimation. Prolactin was assayed according to ***(Lewis et al., 1992; Gonzalez-Mariscal, 2001)*** using a commercial ELISA kit produced by Calbiotech a life science company (PR063f-CBI). The sensitivity of the assay is <0.334 ng/ml.

Data analysis

All data were collected and were evaluated by means of the SPSS

16.0 software package according to ***(Argyrous, 2005)*** to analyses the differences between groups by using one way analysis of variance F-test (Guthoff et al.), according to ***(Cohen, 2002)***, means and standard error were used. Duncan's multiple range test was performed to detect significant differences among means when appropriate according to ***(Duncan, 1955)***. The significance level was set at (P<0.05). A rejection-criterion of 0.05 was set for all statistical tests.

Results

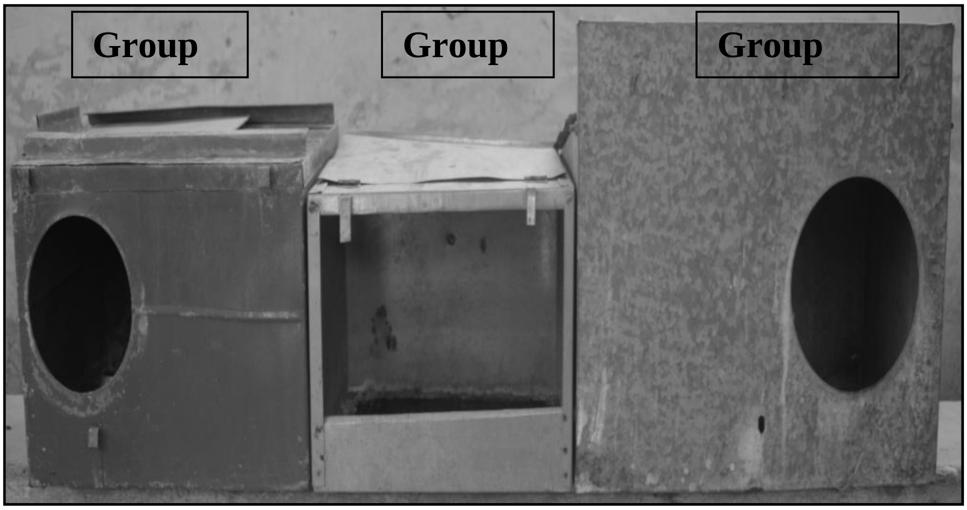

Plate (1): *The three nest box designs, group (A and C) have a circular open with a larger size box in (C). While, group (B) has a fully opened open.*

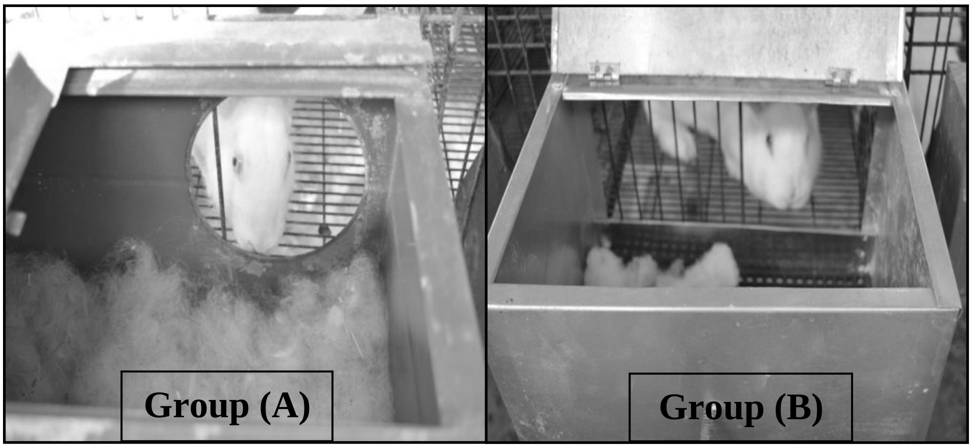

Plate (2): *Rabbit does in the different nest box designs observing their litters*

Plate (3): *Blood samples collection in tubes from marginal ear vein of rabbit then centrifugated for obtaining serum samples*

Plate (4): *Kits placement inside the nest box*

Table (1): *Pre-parturient maternal parameters and post-parturient nest quality traits of rabbit does in different nest box design groups (Means ±S.E)*

Nest quality traits		Group A	Group B	Group C	P-value
Pre-parturient	Nest building (NB)	3.8±0.37	3.8±0.37	4±0.32	0.901^{NS}
	Nest lining (NL)	4±0.32	4±0.32	4.2±0.37	0.89^{NS}
Post-parturient	Nest structure (NS)	4.2±0.37	4.2±0.37	4±0.32	0.901^{NS}
	Fur placement (FP)	4±0.32	4.2±0.37	4.2±0.37	0.901^{NS}
	kit placement (KP)	3.4±0.25	3.2±0.37	3±0.32	0.679^{NS}

There was no significant difference between means at (P > 0.05)
NS. Non-significant at (P > 0.05)

Table (2): *Nursing display parameters during 24 hrs behavioural observation for 6 days postpartum of rabbit does in different nest box design groups (Means ±S.E)*

Nursing display parameters	Group A	Group B	Group C	P-value
Number of nursing events	1.19^{b}±0.09	1.42^{ab}±0.23	2.09^{a}±0.46	0.034^{*}
Length of nursing events (Min.)	2.79±0.11	3.08±0.20	2.87±0.12	0.328^{NS}
Flash movement frequency	4.18±1.07	4.64±0.99	1.45±0.28	0.12^{NS}
Flash movement duration (Sec.)	6.9^{b}±1.20	22.32^{a}±3.53	11.92^{b}±3.97	0.001^{**}

Means in the same row with different superscripts are significantly different (P ≤ 0.05).
NS: non-significant at P > 0.05 * P ≤ 0.05 ** P ≤ 0.01

Table (3): *Productive and Reproductive performance of rabbit does in different nest box design groups (Means ±S.E)*

Parameters	Group A	Group B	Group C	P-value
Body weight of does (kg)				
At kindling	3.145±0.08	3.415±0.12	3.447±0.09	0.174^{NS}
At weaning of their litters	3.207±0.14	3.362±0.21	3.644±0.15	0.297^{NS}
Litter size				
Total born	7.00±0.55	7.12±0.47	6.67±0.21	0.815^{NS}
Born alive	7.00±0.55	7.12±0.47	6.67±0.21	0.815^{NS}
Stillborn	0.22±0.15	0.25±0.16	0.17±0.17	0.940^{NS}
At 21 days of age	6.14±0.71	6.14±0.77	5.20±0.58	0.616^{NS}
At 30 days of age	6.14±0.71	6.14±0.77	5.20±0.58	0.616^{NS}
Kit body weight (g)				
At birth	55.87±1.89	60.90±1.96	60.90±3.01	0.221^{NS}
At 21 days of age	343.37±7.05	365.00±14.47	327.54±15.15	0.121^{NS}
At 30 days of age	496.00^{b}±16.27	599.37^{a} ±10.21	597.78^{a} ±35.18	0.001**
Total pre-weaning mortality (%)	12.14±5.36	28.62±11.43	35.67±15.11	0.353^{NS}
Milk production (Kg)	4.81±0.48	4.54±0.42	4.19±0.33	0.619^{NS}

Means in the same row with different superscripts are significantly different (P ≤ 0.05).
NS: non-significant at P > 0.05 * P ≤ 0.05 ** P ≤ 0.01

Table (4): *Prolactin hormone levels (ng/ml) of rabbit does in different nest box design groups (Means ±S.E) at parturition and at 21 day postpartum*

Groups	Prolactin hormone levels (ng/ml)	
	At parturition	At 21 day postpartum
Group A	0.90±0.15	22.44±3.66
Group B	0.87±0.11	18.89±1.93
Group C	1.37±0.26	23.03±4.35
P-value	0.114^{NS}	0.663^{NS}

There was no significant difference between means at (P > 0.05)
NS: non-significant at (P > 0.05)

Discussion

The results in table (1) showed that there was no significant difference (P > 0.05) between the three nest box designs A, B and C in nest quality traits scores before parturition as nest building (3.8±0.37,3.8±0.37,4±0.32), nest lining (4±0.32, 4±0.32 and 4.2±0.37). In addition to, after parturition scores as nest structure (4.2±0.37, 4.2±0.37 and 4±0.32), fur placement (4±0.32, 4.2±0.37 and 4.2±0.37) and kit placement (3.4±0.25, 3.2±0.37 and 3±0.32) respectively. These nearly similar nest quality traits scores among the different nest box designs may be attributed to there was no significant changes in prolactin hormone levels that promotes maternal nest-building in rabbits according to ***(Negatu and McNitt, 2002; González-Mariscal, 2004)***. In view of these results it's clear that there was no effect of three nest box designs A, B and C on the nest quality traits of rabbit does before and after parturition.

Concerning nursing display parameters as shown in table (2) the results revealed that a significant difference (P ≤ 0.05) in the frequency of nursing events between the three nest box design groups (1.19±0.09, 1.42±0.23 and 2.09±0.46) and a highly significant difference (P ≤ 0.01) in flash movement duration (6.9±1.20Sec., 22.32±3.53Sec. and 11.92±3.97 Sec.) respectively. But, there was no significant difference (P > 0.05) in length of nursing events (min.) and flash movement frequency. The higher frequency of nursing events in the larger nest box group C than the others was in agreement with ***Seitz et al. (1998)*** *and* ***Hoy et al. (2000)***. On the other hand, this result disagreed with ***Selzer et al. (2004)*** who noted that there was a high ability to decrease the nursing activity with increasing cage dimensions and the presence of a subway at the entrance to nest box. This finding may be attributed to rabbit doe may use the nest box as a sanctuary when alarmed to be more calm according to ***González-Redondo (2003)*** and larger size box is more suitable and comfortable according to ***Mykytowycz (1959)***.

The longer time of flash movement was obtained in fully opened nest box group B and this may be due to continuous visual communication between kits and doe which forced her to enter the nest box. This visual communication exaggerate the nursing stimulus coming from kits ***(Baumann et al., 2005a; 2005b)***. On the other hand, circular opened nest box in group B make no or more controlled visual communication between the doe and her litter which decrease the number of stimulus the doe received from her litters.

The results in table (3) cleared that body weight of the does at kindling and at weaning of their litters, did not significantly differ (P > 0.05) between groups. This may be due to, there was no any change in feed intake. Results also revealed that, the litter size at birth (born alive and still born), at days 21^{st}, 30^{th} of age and the total pre-weaning mortality of kits did not significantly differ (P > 0.05). The in ability of kits to maintain a constant body temperature in nest box group B and C vs. group A leaded to smaller litter sizes because of higher mortalities (28.62±11.43, 35.67±15.11 vs. 12.14±5.36) respectively. This result agreed with ***Parer et al. (1987)*** and ***González-Redondo (2006)***.

Considering kit body weight (g) at 30 days of age there was a highly significant difference (P ≤ 0.01) between the three nest box designs A, B and C (496.00, 599.37 and 597.78) respectively. This higher kit body weight (g) in nest box group B and C may be attributed to smaller litter size from higher mortality that increase the chance for kits to suckle larger amount of milk. This explanation is consistent with ***Mohamed and Szendro (1992)***.

Results in table (4) revealed that there was no significant difference (P > 0.05) between the three nest box designs A, B and C in Prolactin hormone levels (ng/ml) of rabbit does in different nest box design groups at parturition (0.90±0.15, 0.87±0.11 and 1.37±0.26) and at 21 day postpartum (22.44±3.66, 18.89±1.93, 23.03±4.35). This finding was in agreement with ***Durand and Djiane (1977)*** who confirmed that the release of pituitary prolactin into the circulation of the lactating mother depends on the action of milking or suckling stimulates.

Conclusion

Large or fully opened nest box designs had a positive effect on nursing events durations (min.), flash movement duration (sec.) and mean body weight (g) of kits at 30 days of age. However, such conditions do not affect other recorded parameters.

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