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Original Article

Effect of season and housing systems on various physio-behavioral attributes of local breed of rabbits (*Oryctolagus cuniculus*) in Southern Punjab, Pakistan

Efeito da estação e dos sistemas de alojamento em vários atributos fisiocomportamentais da raça local de coelhos (*Oryctolagus cuniculus*) no sul de Punjab, Paquistão

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Abstract

The present study was conducted to investigate the effect of season and various housing systems on behavioral *i.e.* sitting, standing, walking and physiological *i.e.* respiratory rate (RR), rectal temperature (RT), time of sexual libido (TSL) attributes of local breed of rabbits reared in Southern Punjab, Pakistan. Adult rabbits (n = 40) of 6 month to 1 year old were divided into two groups (n = 20 / group). Group I was placed under traditional colony system in the soil while group II was kept under modern cage system. Sitting and standing was significantly ($p \leq 0.05$) higher during summer and winter respectively. The RR and RT were significantly ($p \leq 0.05$) higher in summer as compared to other study seasons. Standing behavior was significantly ($p \leq 0.05$) higher in caged rabbits as compared to colony-reared ones. Statistically higher ($p \leq 0.05$) TSL value was observed in summer as compared to other three study seasons. From this study it is concluded that rabbit's behavioral and physiological traits are significantly affected by season and housing systems. We concluded that rabbits show better physio-behavioral performance in autumn and winter season while summer stress negatively affects physiology and behavior under caged-system. This study could contribute new aspects of behavioral and physiological processes in local breed of rabbits due to different seasons and housing systems.

Keywords: *Oryctolagus cuniculus,* respiratory rate, rectal temperature, housing systems.

Resumo

O presente estudo foi conduzido para investigar o efeito da estação do ano e de vários sistemas de alojamento nos atributos comportamentais, isto é, sentar, levantar, andar e fisiológico, isto é, frequência respiratória (RR), temperatura retal (TR), tempo de libido sexual (TSL), atributos da raça local de coelhos criados no sul de Punjab, Paquistão. Coelhos adultos (n = 40) de 6 meses a 1 ano de idade foram divididos em dois grupos (n = 20 / grupo). O grupo I foi colocado sob o sistema de colônia tradicional no solo, enquanto o grupo II foi mantido sob o sistema moderno de gaiolas. Sentar e ficar em pé foi significativamente ($p \leq 0,05$) maior durante o verão e inverno, respectivamente. O RR e o TR foram significativamente ($p \leq 0,05$) maiores no verão, em comparação com as outras estações do estudo. O comportamento em pé foi significativamente ($p \leq 0,05$) maior em coelhos engaiolados, em comparação com os criados em colônia. O valor de TSL estatisticamente maior ($p \leq 0,05$) foi observado no verão, em comparação com outras três temporadas de estudo. A partir deste estudo, concluiu-se que os traços comportamentais e fisiológicos dos coelhos são significativamente afetados pela estação do ano e pelos sistemas de alojamento. Concluímos que os coelhos apresentam melhor desempenho fisiocomportamental no outono e inverno, enquanto o estresse do verão afeta negativamente a fisiologia e o comportamento em sistema enjaulado. Este estudo pode contribuir com novos aspectos dos processos comportamentais e fisiológicos em raças locais de coelhos devido às diferentes estações do ano e sistemas de alojamento.

Palavras-chave: *Oryctolagus cuniculus*, frequência respiratória, temperatura retal, sistemas de habitação.

1. Introduction

Rabbit rearing is considered a good strategy to meet the demand of meat in many developing countries (Khalil et al., 2016). Rabbit meat has several advantages including high protein content and low cholesterol content, higher nutritive value, and better taste (Moustafa et al., 2014). Current breeds of rabbits present in tropics being

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descendants of European rabbit of cold environment are facing welfare problems related to summer season. Similarly, rabbits are social animals and modern intensive form of rabbit farming in small cages is also challenging their welfare in the form of restricted natural behavioral expression. In Pakistan, the Northern areas represent the largest rabbit farming, and these rabbits are reared for the purpose of meat, occupation, and as pet animals. Rabbits are mostly kept in the colony system making burrows in soil with or without a mud and concrete shelter (Khan et al., 2014). It has already been well established that indigenous local breed of rabbits can produce meat more efficiently in the cage system with better-quality of feeding and hygienic conditions (Khan et al., 2017a; Khan et al., 2017b).

Season plays a significant role in rabbit production and welfare through various aspects including temperature, relative humidity, and lighting (Holik, 2015). Behavioral attributes are frequently considered the starting point for evaluating an animal's reaction to ambient temperature and relative humidity in its surroundings varying with seasons (Dawkins, 2003). The behavioral and physiological state of an animal helps in the detection of various diseases and stress conditions like nutritional, physical, and environmental conditions that lead to changes in metabolism, growth, immune functions, and reproductive capacity (Barton et al., 2002). Wild rabbits usually live-in colonies but two or three rabbits can be kept in one cage in a cage housing system. Szendrő et al. (2016) have discussed the significance of different housing systems of rabbits including individual cage and colony systems. Many authors studied different housing systems befitting to rabbits' welfare and compared the behavior of rabbits in small cages and colony systems (Verga et al., 2006).

The forage resources are quite favorable for rabbit-raising in Pakistan. The existing housing pattern in the Southern region is not according to scientific lines. In the rural areas, rabbits are mostly kept under a traditional colony system. The production of rabbits in Pakistan under the current cage system is very low (Khan et al., 2016). A lot of studies have been conducted on the behavior and physiological attributes of many animals but no such study has been conducted on rabbits concerning seasons and housing systems in Southern Punjab, Pakistan to date. The present study has, therefore, been devised with the main objective to assess the effect of season and various housing systems on behavioral (sitting, standing, walking) and physiological (RR, RT, and TSL) attributes of the local breed of rabbits being reared in Southern Punjab, Pakistan.

2. Material and Methods

2.1. Study site

This experiment was carried out at Tehsil Khan Pur, District Rahim Yar Khan, a city of Southern Punjab, Pakistan from March 2020 to February 2021 (Figure 1). The district climate is characterized by a high temperature (up to 120 °F), uneven humidity, low rainfall, and a high evaporation rate (Mahar et al., 2015).

2.2. Experiment

Adult rabbits (n = 40) of 6 months to 1 year old were divided into two groups (n = 20 / group). Group I was placed under a traditional colony system in the soil while Group II was reared in the modern cage system. Rabbits

Figure 1. Map of Pakistan with coordinates and legends indicating Rahim Yar Khan District.

Table 1. Mean (± SE) values for behavioral attributes of rabbits during different seasons.

Seasons	Sitting (Per 300 seconds)	Standing (Per 300 seconds)	Walking (Per 300 seconds)
Spring	159.8 ± 5.6 [a]	109.3 ± 4.8 [a]	31.5 ± 2.8 [a]
Summer	215.2 ± 5.9 [b]	37.3 ± 3.6 [b]	46.3 ± 5.7 [b]
Autumn	93.9 ± 6.7 [c]	153.0 ± 8.8 [c]	50.7 ± 4.5 [b]
Winter	38.6 ± 4.0 [d]	217.4 ± 6.4 [d]	43.8 ± 4.1 [b]

Different superscripts within the column are significantly different ($p \leq 0.05$).

Table 2. Mean (± SE) values for physiological attributes of rabbits during different seasons.

Seasons	Respiratory Rate (Per minute)	Rectal Temperature (°F)
Spring	115.4 ± 2.4 [a]	101.5 ± 0.06 [a]
Summer	132.1 ± 2.9 [b]	101.7 ± 0.06 [a]
Autumn	107.4 ± 1.8 [c]	100.3 ± 1.5 [b]
Winter	114.3 ± 2.1 [a]	99.6 ± 0.2 [c]

Different superscripts within the column are significantly different ($p \leq 0.05$).

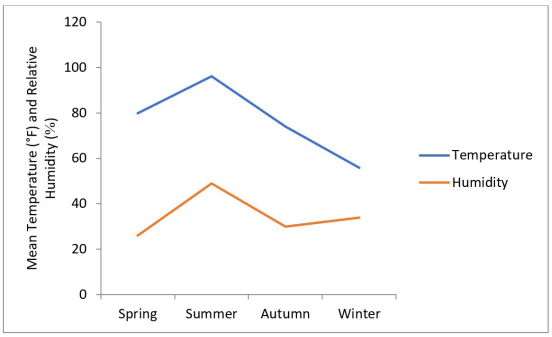

Figure 2. Mean values for meteorological attributes during different study seasons.

were purchased from local farmers which keep the rabbits under a traditional colony system. Health status was ascertained before purchase and healthy rabbits only were purchased. A brick-built shed with a wire mesh fence of 18 × 18 × 10 ft length, width, and height was used for the experiment. Welded wire mesh cages with wire mesh floor having moveable waste collecting trays (36 inches length, 30 inches width, and 18 inches height) were kept in the shed. Seasonal local fodders like berseem (*Trifolium alexandrinum)*, alfalfa (*Medicago sativa*), jantar (*Sesbania bispinosa*), vegetables and cotton leaves were offered according to the season as basal diet twice daily. All rabbits had ad-libitum access to clean drinking water placed in metallic bowls.

The behavioral activities of each rabbit *viz*. sitting, standing and walking of Group I and II were recorded visually for 300 seconds (05 minutes) (Khalil et al., 2014). Group I was monitored from 9 - 11 am, whereas Group II was monitored throughout an hour.

The thermo-respiratory traits including RR and RT were calculated in both groups through the conventional method using a stop watch. The RR was calculated in rabbits by counting the chest muscle movements for 60 seconds, whereas RT was taken through a clinical rectal thermometer (Khalil et al., 2014). The TSL for each male rabbit under a cage system was also observed. The teaser doe was introduced to the male rabbit's cage and TSL measured when the male rabbit start mating (Elkomy et al., 2015).

Temperature (°F) and relative humidity (%) of the farm was recorded through HTC-1 Digital hygrometer same day of each month throughout the year while behavioral and physiological traits were being measured.

2.3. Statistics

Statistical analysis was conducted through Statistical Package for Social Science (SPSS for Windows version 12, SPSS Inc., Chicago, IL, USA). Data is presented in mean (± SE). Independent samples T-Test and one-way ANOVA with Duncan's multiple range test post-hoc test was implied to determine the effect of housing systems and season, respectively.

3. Results

The effect of season on various behavioral attributes is presented in Table 1. Sitting and standing was significantly ($p \leq 0.05$) higher during summer and winter respectively. The effect of season on various physiological attributes is presented in Table 2. The RR and RT were significantly ($p \leq 0.05$) higher in summer as compared to other study seasons. Seasonal mean temperature (°F) and relative humidity (%) is presented in Figure 2. Mean temperature and relative humidity inside the rabbit farm for the period under experimentation during spring to winter ranged from 56 to 96 °F and 26 to 49%, respectively. Average mean temperature and relative humidity during spring, summer, autumn and winter season were recorded as 79.8 °F and 26%, 96.08 °F and 49%, 73.94 °F and 30%, 55.94 °F and 34%, respectively.

The effect of housing systems on various behavioral attributes is presented in Figure 3. Standing behavior was significantly ($p \leq 0.05$) higher in caged rabbits as compared to colony-reared ones, whereas sitting was non-significantly ($p \geq 0.05$) higher in colony-reared rabbits. The effect of various housing systems on physiological attributes is presented in Figure 4. The RR was significantly ($p \leq 0.05$) different for both study groups. The effect of seasons on TSL is presented in Figure 5. Statistically higher ($p \leq 0.05$) TSL value was observed in summer as compared to the other three study seasons.

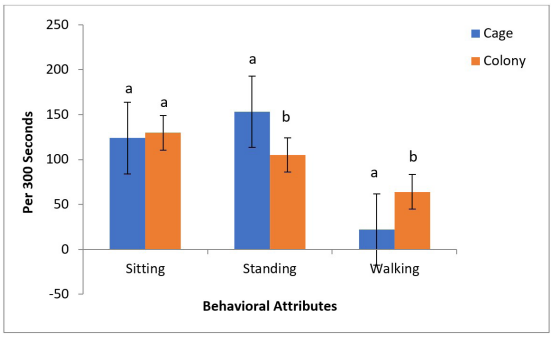

Figure 3. Effect of housing systems on various behavioral attributes of rabbits. Data is mean (± SE). Similar letters on the bars indicate non-significant ($p \geq 0.05$) difference within caged and colony reared rabbits for sitting. Different letters on the bars indicate significant ($p \leq 0.05$) difference within caged and colony reared rabbits for standing and walking.

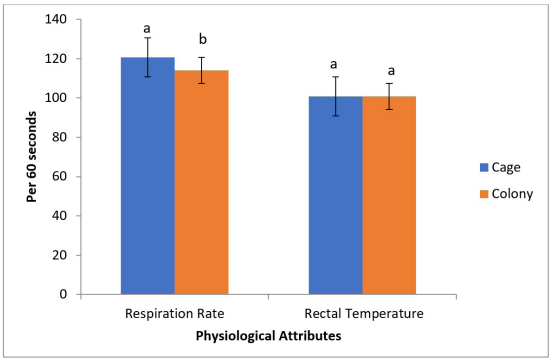

Figure 4. Effect of housing system on various physiological attributes of rabbits. Data is mean (± SE). Similar letters on the bars indicate non-significant ($p \geq 0.05$) difference within caged and colony reared rabbits for rectal temperature. Different letters on the bars indicate significant ($p \leq 0.05$) difference within caged and colony reared rabbits for respiration rate.

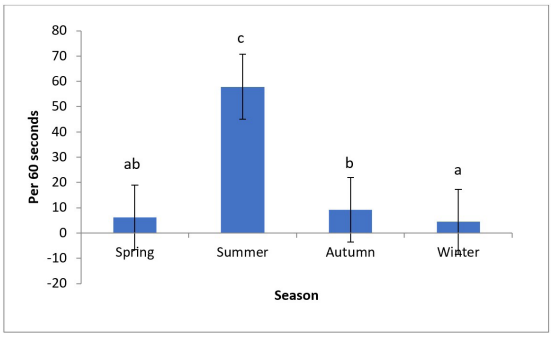

Figure 5. Effect of seasons on TSL of male rabbits under cage system. Data is mean (± SE) and different letters on the bars depict statistical difference at ($p \leq 0.05$) for seasons.

4. Discussion

The present study is the first of its kind being reported with an aim to assess effect of various seasons and housing systems on local breed of rabbits in Southern Punjab, Pakistan.

Results of the present study revealed that season and housing systems affected significantly on most of the studied traits of rabbits. Sitting was significantly higher during summer while standing during winter. Similarly, there was a significant difference for walking during spring and rest of the three study seasons. In our study, mean temperature of rabbit farm during summer was 96.08 °F and 55.94 °F during winter season. Heat stress during summer asserted rabbits to sit more time on the floor. Our results are in agreement with the prior results of Khalil et al. (2012) who reported that behavior of quail birds significantly altered by increased temperatures. Birds reared at 95 °F tended to spend more time sitting and less time standing and walking as compared with the 77 °F group. It has also been elucidated that summer stress significantly increased sitting time in quail birds. A plausible justification could be that the animals try to enhance heat loss through heat transmission to the floor of the cage which increases sitting behavior in animals.

In the present study, there was a significant difference of RR during spring, summer and autumn while non-significant difference was noticed between winter and spring seasons. The RT was significantly higher during spring and summer as compared to autumn and winter seasons. These results are also in agreement with previous report by Askar and Ismail (2012), who stated that RR and RT significantly increase due to high temperature in summer. Optimal air temperature for rabbit production should be between 59 to 68 °F. However, in our study, mean temperature during summer was 96.08 °F which is not suitable for normal rabbit production. Productive efficiency is decreased in heat stressed rabbits due to increased body temperature and RR (Ashour and Shafie, 2002). High RR is necessary to maintain homeothermy in rabbits by stimulating evaporative heat loss (Zeferino et al., 2011). Our study also matches with other previous studies which have found highest rabbit RT during summer and the lowest during winter season (Kishk et al., 2009). In contrast to our study, another study reported that RR and RT of doe rabbits didn't differ significantly during mild winter and hot summer conditions (Marai et al., 2001).

Regarding the behavioral attributes, there was a non-significant difference in sitting behavior under cage and colony housing systems as compared to standing and walking behavior which had a significant difference in our study. These results are in accordance with a previous study of Trocino et al. (2013) who reported that the housing system did not affect the expression of the main activity "resting". The term "resting" in our study is known as "sitting". Dal Bosco et al. (2002) suggested that rabbits should be reared in larger groups (colony system) which provides platform to rabbits for walking, running and jumping. They have an easy mobility (Maertens and Van Oeckel, 2001). The floor space available to the group-housed rabbit allows them to run, jump and kick in the air as evident from the results of the present study.

For physiological attributes in our study, a significant difference of RR under cage and colony systems was observed. RR was significantly higher in caged rabbits with respect to colony rabbits. Throughout the experimental period no clinical signs of any respiratory disease were

observed. The significance difference in RR was due to the seasonal variation or different housing systems. This study results match with the previous study of Rahman et al. (2018) who reported a significantly higher RR (41.2±7.29) caged Angora rabbits as compared to indoor colony rabbits (39.3±6.30). The difference possibly attributed to stress in housing system which increases the mean RR. Colony rabbits kept in open environment were more adapted to their environment because there was adequate accessibility of fresh air and less stressful condition. Parallel to our findings, Pavlova et al. (2005) found that animals living in the open field as a colony showed longer respiratory cycle than those housed in cages.

Our study showed some variability in RT among both groups during the research but there was a non-significant difference of RT under cage and colony systems. These results are parallel with the results of a previous study of Rahman et al. (2018) who documented that RT of Angora rabbit changes, but there was non-significant ($p \geq 0.05$) difference of RT found between other groups of his study. Okab et al. (2008) suggested that physiological functions of New Zealand rabbits may adversely affected by hot environmental conditions.

According to this study, the TSL value for male rabbits under cage system was significantly different for all seasons except spring. Our result matches with the previous study of Kishk et al. (2009), who found that NZW bucks had faster TSL under winter conditions than in summer conditions. The results of El-Sabrout and Shebl (2015) showed that the rabbits raised in winter had significantly higher feeding and sexual desire than rabbits raised in summer. Libido is delayed possibly due to the reduction in testosterone concentration and minimal spermatogenesis and/or the low-quality semen occurring in a hot climate (Zeidan et al., 1997).

5. Conclusion

From this study it is concluded that rabbit's behavioral and physiological traits are significantly affected by season and housing systems. They tend to maintain their bodily homeostasis as per the surrounding environment which ultimate effects their production attributes as well. We concluded that rabbits show better physio-behavioral performance in autumn and winter season while summer stress negatively affects physiology and behavior under caged-system. This study could contribute new aspects of behavioral and physiological processes in local breed of rabbits under different season and housing systems. It can allow for developing of new housing and production systems that are more suitable for the specific climatic condition.

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