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# NOTE : RELATIONSHIP BETWEEN SCROTAL TEMPERATURE AND SPERM MORTALITY OF THE NEW ZEALAND WHITE RABBIT

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**ABSTRACT** : Eight mature New Zealand White bucks (3049 ± 247g live weight) were randomly allocated to one of 4 groups in descending order of the density of their semen. Rabbits were raised at 20°C except during a single short period of 8 hours when they were introduced in a climatic chamber (CC) regulated at 20°C [control], 32°C, 32°C + infrared heating at 1,9MJ/m²/h or 34°C (groups 1 to 4). Semen quality was evaluated before treatment and then once a week during 8 consecutive weeks. During the stay in the CC, scrotal temperature increased rapidly within the first hour. Average scrotal temperature increased ($P < 0.05$) with each short-term environmental temperature increase : 34.1° – 36.5° – 37.0° and 37.9°C for groups 1 to 4 respectively. The maximum level of dead sperm was recorded at the first week after hotroom exposure in each of the 3 experimental groups. Between temperatures, the highest level of mortality (16.3%) was recorded in the 34°C group, followed by 32°C + i.r. and 32°C (11.3 and 7.8%). It was only 1% in the control group. A total of 3 weeks after treatment was required for the incidence of sperm mortality to return to normal. As a whole, it can be concluded that the exposure of bucks to short-term high ambient temperature is followed by a significant degree of seminal degeneration.

**RESUME: Note: Relations entre la température scrotale et la mortalité des spermatozoïdes chez le lapin Néo-Zélandais Blanc.**
Huit lapins adultes de génotype Néo-Zélandais Blanc (poids moyen 3049 ± 247 g) ont été également répartis entre 4 groupes en fonction de la densité de leur semence. Les lapins ont été élevés à une température ambiante de 20°C en dehors de la période expérimentale unique où ils ont été placés dans une chambre climatique (CC) réglée à 20°C [témoin] - 32°C - 32°C avec chauffage infrarouge de 1,9MJ/m²/h ou 34°C pendant une durée de 8 heures (lots 1 à 4). La qualité de la semence a été contrôlée au départ et ensuite une fois par semaine durant 8 semaines consécutives. Au cours du séjour dans la CC, la température scrotal s'accroît rapidement (en une heure) avec la température ambiante (de 34,1° pour le témoin à 36,5°C – 37,0 et 37,9°C pour les lots 2 à 4 respectivement). Le taux de spermatozoïdes morts le plus élevé est observé une semaine après le traitement en CC chaude. Ce taux s'accroît avec la température de la CC, de 1% pour le lot 1 à 16,3% pour le lot 4. Le niveau de base n'est retrouvé que 3 semaines après le passage en CC chaude. Les auteurs concluent qu'un dégénérescence séminale est observée chez le lapin à la suite d'une exposition courte à une température élevée.

## INTRODUCTION

Little work has been reported on the relationship between short-term exposure to high environmental temperature (ET) and sperm mortality in the buck of New Zealand White (NZW) rabbit. The work of RATHORE (1970) revealed no significant differences in semen volume, sperm density or the incidence of pyriform cells between control bucks and those exposed to 36.1°C and 45% RH for 8 hours on either 1 or 2 days.

However, in the ram, much work has been done and it was concluded that short-term exposure to high temperature leads to temporary (over 6-8 weeks) deleterious effects on semen volume, motility, density and the proportion of live sperm (BRADEN and MATTNER, 1970). These results, from intensive studies, suggest that further work is required in rabbits, therefore, the current experiment was undertaken to investigate the effects of different heat stressors on scrotal temperature and sperm mortality of NZW rabbit.

## MATERIALS AND METHODS

Eight mature NZW bucks (3049 ± 247g live weight) were randomly allocated to one of 4 groups (Table 1) in descending order of the density of their semen. During the 8 hours of exposure, room temperature was constant without (groups 1, 2 and 4) or with (group 3) additional infrared heating. Before and after the test, the bucks were individually housed at 20°C, fed and watered *ad-libitum*. All bucks had been trained to serve the artificial vagina (MACIRONE and WALTON, 1938), and throughout the experiment semen was collected once weekly.

The proportion of live sperm was calculated from direct microscopic counting of 200 cells in negrosin/eosin stained smears (BUTTLE *et al.*, 1965).

The experiment ran for 9 weeks. Temperature stress was applied to Groups 2, 3 and 4 for 8 hours. On that day, scrotal temperature (ScT) was measured in the control room at 09:00 h and the rabbits of groups 2, 3 and 4 were then transferred to their respective treatments in the adjacent climate chamber. At hourly

**Table 1 : Groups and experimental treatments**

| Group | No. of rabbits | °C | i.r. heating |
|---|---|---|---|
| 1 | 2 | 20 | - |
| 2 | 2 | 32 | - |
| 3 | 2 | 32 | 1.9 MJ/m²/h |
| 4 | 2 | 34 | - |

**Table 2 : Mean scrotal temperature of unacclimated male NZW rabbits exposed to different environmental temperature for 8 hours**

| Groups | 1 | 2 | 3 | 4 | SEM | Level of Significance |
|---|---|---|---|---|---|---|
| Room temperature °C | 20 | 32 | 32 + i.r. | 34 | - | |
| Scrotal temperature °C | 34.1a | 36.5b | 37.0c | 37.9d | 0.1 | *** |

Values within the same line with dissimilar superscripts differ significantly ($P < 0.05$)

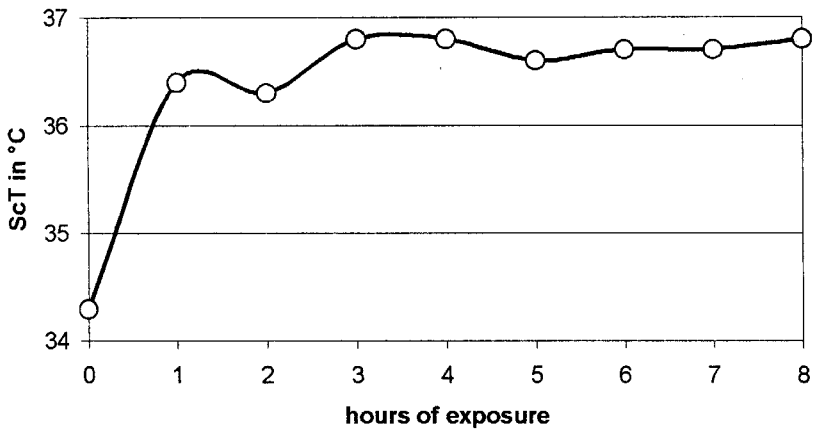


**Figure 1 : Average scrotal temperature during the high temperature exposure (sem = 0.2°C; only evolution during the first hour is significant at P=0.05).**

intervals until 17.00 h, when the experimental bucks were returned to their cages at 20°C, the same variable was measured as indice of the thermal stress experienced. Semen continued to be collected and evaluated weekly until the experiment ceased.

## RESULTS AND DISCUSSION

### Scrotal Temperature (ScT)

Scrotal temperature differed ($P < 0.05$) with ET. It increased gradually and progressively with rising ET from 20° to 34°C (Table 2); and once again the greatest difference was between 20°C and the 3 hotroom treatments. The differences between the individual hotroom treatments were each statistically significant (Table 2), but the magnitudes of them (0.5 to 1.4°C) and the fact that all values were above the generally accepted threshold for normal spermatogenesis (about 34-35°C; BRADEN and MATTNER, 1970), suggests that differential effects on semen quality should not be anticipated. At different times of exposure, ScT also differed significantly; the most rapid increase being during the first hour (34.3 ± 0.4 to 36.4 ± 0.6°C). Thereafter, steady level of from 36.3 to 36.8°C was maintained without any significant variation, until the end of exposure (Figure 1).

From these results it can be concluded that ScT all increased with rising ET. In previous experiments rabbits tolerated 7 hours exposure at 32°C and 1.9 MJ/m²/h i.r. radiant heating; a response which is in line with the 8-hour tolerance of all 3 treatments (32.2-34°C) in the current experiment. With respect to both rabbits (FUKUI, 1923) and cattle (BEAKLEY and FINDLAY, 1955) it has been reported that ScT increases gradually with rising ET. In cattle, when ET increased from 15° to 40°C, ScT increased from 31.9° to 37.1°C, while in rabbits it was shown that bathing the scrotum in water (44°-45°C) for 3 hours caused histological destruction of the generative cells of the seminiferous tubules. Subsequently, as the canaliculus gradually atrophied, the interstitial and Leydig cells proliferated. When the scrota of rabbits were exposed to strong sunlight for three hours, and when the testes were kept at 41°C for nine hours per day for nine days, histological degeneration also occurred. In the current experiment when ET was increased from 20° to 34°C for 8 hours, ScT increased from 34.1° to 37.9°C. Histological studies were not possible in the current work since the number of bucks available was limited, but comparison of scrotal skin temperatures (34.1° to 37.9°C) with the 44-45°C induced in FUKUI's (1923) work (but only for 3 hours) suggests that histological degeneration in the current bucks was unlikely to have been so severe.

### Sperm Mortality (%)

Data on sperm mortality was presented in Table 3. The maximum level of dead sperm was recorded at the first week after hotroom exposure in each of the 3 treatments. Between temperatures, the highest level of mortality was recorded in the 34°C group, followed by 32°C + i.r. and 32°C. At 1 week after hotroom treatment these 3 groups differed from controls by factors of 16x, 11x and 8x respectively.

The corresponding means of mortality values for the same 3 treatments were 7.5x, 5x, and 4x higher than in controls (Table 3). Mortality values began to decline at the 2nd week after treatment and continued to do so till week 4, by which time the pre-treatment level was regained.

It may be concluded that % sperm mortality increased with rising ET, with maximum values being recorded after 1 week. A further 3 weeks were required for the incidence of sperm mortality to return to normal as it was previously observed by the same authors after a 8 hours exposure to 34°C (KASA and THWAITES,

**Table 3 : Mean sperm mortality (%) of unacclimated male NZW rabbits exposed to different environmental temperatures (20°C-34°C)**

| Week | Experimental groups | | | | Mean |
|---|---|---|---|---|---|
| | 20°C | 32°C | 32°C + IR | 34°C | |
| 0 | 0.6 | 0.4 | 0.0 | 0.5 | 0.4 |
| 1 | 1.0 | 7.8 | 11.3 | 16.3 | 9.1 |
| 2 | 1.0 | 2.0 | 3.3 | 4.0 | 2.6 |
| 3 | 0.1 | 2.3 | 2.8 | 3.3 | 2.1 |
| 4 | 0.1 | 0.5 | 0.3 | 0.8 | 0.4 |
| 5 | 0.0 | 0.3 | 0.3 | 0.8 | 0.3 |
| 6 | 0.3 | 0.3 | 0.3 | 0.5 | 0.3 |
| 7 | 0.3 | 0.3 | 0.0 | 0.5 | 0.3 |
| 8 | 0.3 | 0.0 | 0.3 | 0.5 | 0.3 |
| Mean | 0.4 | 1.5 | 2.0 | 3.0 | 1.7 |
| Count | 2 | 2 | 2 | 2 | 8 |

1992) . No other similar findings have previously been reported for the rabbit, but the results are in general agreement with RATHORE (1968), who found the proportion of dead spermatozoa in ram semen to increase following exposure to 40.5°C. In that work, however, the response was more marked than in rabbits in the current study, with 35 to 40% dead sperm being recorded 8-16 days after treatment.

As a whole, it can be concluded that the exposure of both bucks and rams to high ambient temperature is followed by a significant degree of seminal degeneration. In the case of rams, this seminal degeneration has been observed under field conditions (SMITH, 1971) and has been associated with concurrent reductions in fertility (STRANZINGER *et al.*, 1971). In view of the widespread distribution of rabbits throughout the tropics (CHEEKE *et al.* 1987), the current results indicate the need for field studies of the possible association between high temperatures and reduced fertility in commercial rabbits. The current results also suggest that the rabbit's testes may be more resistant to high temperatures than those of the ram, though it is possible also that the hotroom treatments employed here were not so severe as those other authors have imposed upon rams.

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