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INFLUENCE OF CHRONIC HIGH RELATIVE HUMIDITY ON SEMEN QUALITY OF HOT STRESSED BUCKS

FINZI A.*, DAADER A., YAMANI K.**, SOLIMAN A.**, ASKAR A.****

* Unconventional Rabbit-Breeding Experimental Centre, Animal Production Institute, Tuscia University, VITERBO, Italy

** Department of Animal Production, Faculty of Agriculture, Zagazig University, ZAGAZIG, Egypt

ABSTRACT

Semen quality of hot stressed bucks has been investigated in conditions of chronic high relative humidity. Bucks were exposed to 32ºC for 22 hours a day in a climatic chamber with a two hours remission period at 25ºC. Six bucks received supplementary stress by 85 % RH while six animals were maintained to 70 % RH. Extremely bad effects ($P<0.001$) have been noticed on progressive linear motility (%), sperm concentration per ml and dead and abnormal spermatozoa (%). These traits tumbled down quickly after two or three weeks of humidity stress, reaching the worst values after four to six weeks. Thereafter, they remained at that situation for three or four weeks then began to improve as time advanced. Nevertheless, they remained worst than that of the bucks maintained under standard humidity. Ejaculate volume did not show any significant differences between standard and chronic high humidity. Nevertheless, it increased significantly ($P<0.001$) due to the high ambient temperature under the two levels of humidity.

INTRODUCTION

High ambient temperature is a well known factor impairing reproductive ability of rabbits during hot months in tropical and subtropical areas (Kuzminsky et al., 1990; Xu et al., 1992 and Finzi et al., 1994, 95). In Egypt, as in many other African countries, relative humidity during the hot months is normally over 85 % during the day and can reach 100% during the night. However, studies on the effects of chronic high relative humidity under hot conditions are lacking. The present research was conducted to investigate the effect of this climatic factor on semen quality.

MATERIAL AND METHODS

Twelve Grimaud hybrid rabbit bucks of similar age (10 months) and body weight (4.98±0.14 kg) were used. The animals were fed *ad libitum* a pelleted rabbit diet of 16% crude protein, 16.5% crude fibre and 11.44 Mj/kg digestible energy.

Bucks were trained for semen collection by an artificial vagina and were placed in a climatic chamber for an initial adaptation period of three weeks, where ambient temperature and relative humidity were programmed at 20ºC and 70% respectively.

The animals were then divided into two experimental groups (6 bucks/group) lacated in separate climatic chambers for a treatment period of six weeks. Both groups were exposed to a mean ambient temperature programmed at 32ºC, while relative humidity treatments were programmed at 70 for one group and 85 % for the other. The exposure time was 22 hours a day with a relative remission of two hours, where ambient temperature and relative humidity were programmed at 25ºC and 70 %, respectively. The animals of the two groups were then exposed again for eleven weeks to a mean ambient temperature and relative humidity similar to that of the adaptation phase. The total experimental period was twenty weeks in which environmental conditions were perfectly controlled. The experiment began at the first of October 1997.

Heat stress were expressed as temperature - humidity index (THI) according to Livestock and Poultry Heat Stress Indices, Agriculture Engineering Technology Guide, Clemson University, Clemson, Sc 29634, USA.

The following equation was used:

THI = dry bulb temperature ºF - {0.55 - (0.55 x RH/100)} (dry bulb temperature ºF - 58.00)

According to this guide, there is no heat stress for THI values less 82, moderate heat stress for 82 to <84, severe heat stress for 84 to <86 and very severe heat stress for the higher values.

Values of THI during the experiment were as in the following table:

Trial periods	Temperature (ºC)	Relative humidity (%)	THI index	THI increase over the control (%)	Levels of heat Stress
Control period	20.6 ± 0.8	71.0 ± 3.0	67.3	-	Null
Heat stress	31.8 ± 0.6	69.0 ± 2.0	83.9	24.7	Moderate-sever
Heat -humid stress	31.7 ± 0.5	87.0 ± 4.0	86.8	29.0	Very sever
Remission time	24.8 ± 1.0	73.0 ± 2.0	73.9	9.8	Null

Light/dark rate during the different experimental phases was 12/12 hours as suggested by Lebas et al. (1984). Two consecutive ejaculates were collected from each buck twice a week and semen analysis was performed on the first ejaculate. Progressive linear motility (%), sperm concentration per ml ($x10^6$), dead spermatozoa (%), total sperm abnormalities (%) and ejaculate volume (ml) were examined according to Smyth and Gordon (1967).

Data were submitted to ANOVA using the General Linear Model procedure (SAS, 1993) according to the following model:

$$Y_{ijkl} = \mu + B_i + P_j + W_k + e_{ijkl}$$

where Y_{ijkl} = the observation on the ijkl th ejaculate, μ = general mean, B_i = random effect of the i th buck, T_j = fixed effect of j period, j= 1…..6 (three periods for each group), W_k = fixed effect of k week, k = 1-3, 4……20, and e_{ijkl} = error of the model. Comparisons between the means were evaluated by the least significant difference test.

RESULTS AND DISCUSSION

Heat stress caused a significant (P<0.01) decrease in progressive linear motility thtough the 2nd to the 4th week of stress (Figure 1, Panel A). Then value returned to normality. When relative humidity increased to 85 %, progressive linear motility showed a dramatic decrease. The value was lower than 25.0 % at the 4th week of stress and reached zero at the end of the treatment (P<0.001). Progressive linear motility was not recovered and remained very low until the 4th post-stress week. Then, a slow recovering began but, from the 9th post stress week till the end of the trial. Progressive linear motility stabilized itself around 58.3 % and remained significantly lower than the normal value (P<0.01). This means that high humidity is a very powerful stressing factor when added to high temperature and a permanent effect on sperm quality can be hypothesised. Data from literature were collected under natural conditions. Thus, they can´t be compared with the present ones nor permit to discriminate the effects of temperature and relative humidity. Some authors (Virag et al., 1992 and El-Masry et al., 1994) reported insignificant differences in progressive linear motility between hot and cold months. But, other authors (Amin et al., 1987 and Daader et al., 1996) observed a significant decrease in progressive linear motility during summer periods. These results were attributed to the decrease of gonadotropin releasing hormone (EL-Gaafary, 1994). Since, the improvement of reproductive performance of hot stressed bucks by the therapy with such hormone is possible (Hsu et al., 1989 and El-Gaafary, 1994). Notwithstanding a direct effect of temperature

on testes is possible when animals are no longer able to be in homeostasis (Finzi et al., 1988, 1995) and body temperature is rising probably over the scrotal additive regulation capability.

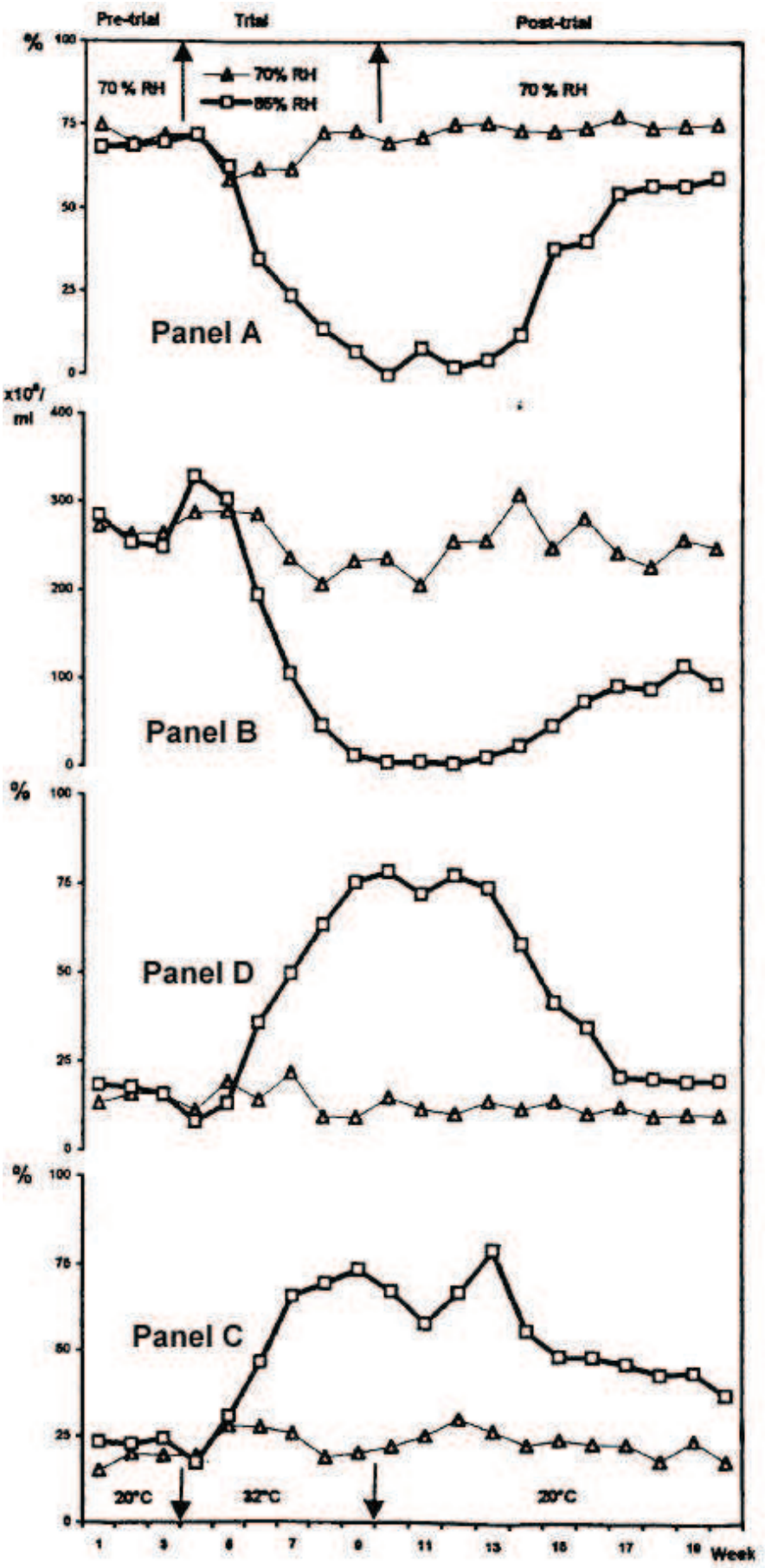


Figure 1. Progressive linear motility (panel A), sperm concentration (panel B), dead spermatozoa (panel C) and total sperm abnormalities (panel D) of rabbits bucks as affected by heat or heat and humidity stress.

Sperm concentration remained normal until the 3rd week of heat stress (Figure 1, Panel B). Then it decreased significantly ($P<0.05$) during the 4th week of stress till the 2nd one of post stress period and returned to the normal value thereafter. Meanwhile, it showed a sharp decline under the high humidity beginning from the 3rd week of stress ($P<0.01$), since reached to the worst level near to zero at the last week of treatment

. Concentration of spermatozoa remained unimproved for four weeks after stopping the treatment. Thereafter, it began to increase but, very slowly till the 8th week. Nevertheless, sperm concentration remained significantly ($P<0.001$) lower than normal value (-64.2 %).

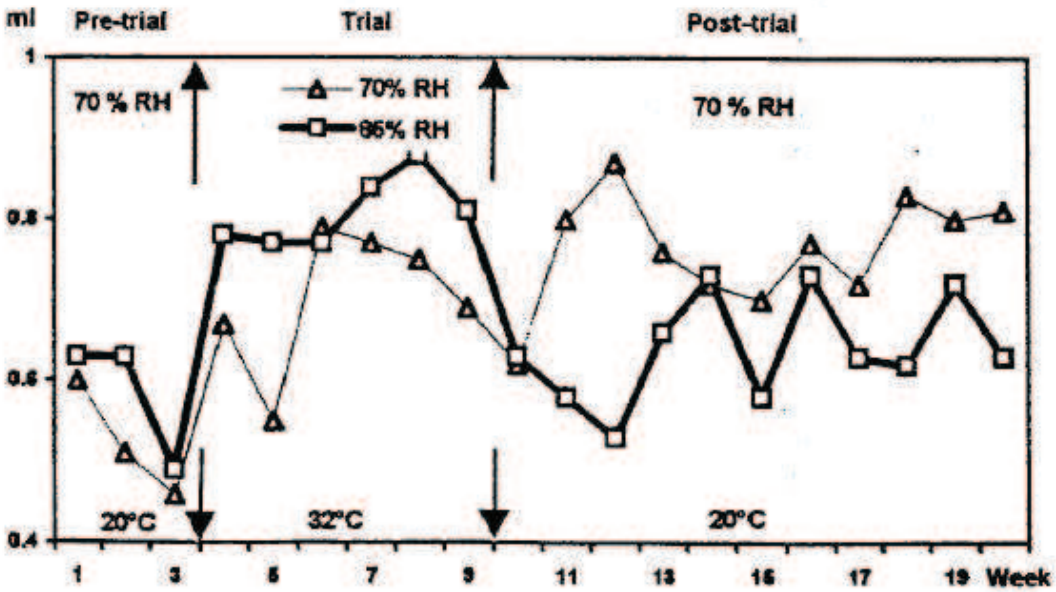
A significant decrease in sperm concentration during the hot months was observed by Amin et al. (1987); Mathur et al. (1989); El-Masry et al. (1994) and Zenat (1994). The decrease in sperm concentration during hot conditions could be attributed to the simultaneous decrease in testosterone concentration in blood (EL-Masry et al., 1994).

Heat-humid stress caused a quick significant increase ($P<0.001$) in dead spermatozoa (%) and total sperm abnormalities (%) by the 3rd week and reaching the worst level at the last week of stress period (Figure 1, Panel C and D). The level of the two parameters remained high till the 4th week of the post-trial period. Starting from the 5th week, they began to decrease gradually. Nevertheless, they remained significantly ($P<0.001$) higher than the normal value till the 7th week for dead sperm and till the end of the experiment for sperm abnormalities. On the other hand, the two traits showed a slight increase due to heat stress but the differences did not reach a significant level except for sperm abnormalities during the 2nd to the 4th week of stress and during the 3rd and 4th week of post-trial period ($P<0.01$).

Increasing dead and abnormal sperms under hot conditions was previously reported by Rastimeshin (1979), Amin et al. (1987) and Finzi et al, (1995). Meanwhile, Virag et al. (1992) and El-Masry et al. (1994) observed an insignificant effect for environmental conditions on sperm abnormalities. These results cannot be attributed to certain environmental factors alone. While, the present trial as it was under controlled conditions, clearly showed the adverse effect of relative humidity along with the environmental temperature. All results regarding progressive linear motility, sperm concentration and dead or abnormal sperms showed typical trends related to the effects of heat, comparatively to heat-humid stress.

The only result not easy to be explained is the one relative to ejaculate volume. Both heat and heat-humid treatments increased significantly ($P<0.05$ or 0.001) ejaculate volume (Figure 2). The effect was more evident ($P<0.05$) when high temperature was combined with high humidity. In the post-stress period, the trend inverted and volume of the hot-humid group was lower than that of heat alone. The present results were taken in perfectly controlled conditions, and were previously observed also by Finzi et al. (1994) in climatic chamber. Similar results have been recorded unchanged values (Virag et al., 1992 and El-Masry et al., 1994) and also a decrease of ejaculate volume as an effect of high temperature (Daader et al., 1997).

Figure 2. Ejaculate volume (ml) of rabbits bucks as affected by heat or heat and humidity stress.



High temperature and relative humidity produce a significant increase of ejaculate volume in controlled conditions, all the other results observed in literature may be attributed to other factors

acting in natural conditions (ventilation, remission of factors during the circadian cycles, low humidity compensating by high temperature, day length, etc.).

It can be seen from these results that chronic hot-humid stress had an extremely strong effect on semen quality. It was of a very high magnitude and lasted for a long time in comparison to the one produced by hot stress alone. This is because high relative humidity depresses body efficiency of heat losing by perspiration. Stress effects became statistically significant, in general, around the 3rd week of stress and lasted for 3 - 4 or 7 - 8 weeks under hot or hot-humid stresses, respectively. Thereafter, in the first group, semen quality was improved and stabilised itself around a constant rate till the end of the experiment, which was in a normal level and similar to that of the pre-stress period. In the second group, semen characters did not recover and remained worst than in the control period. Consequently, a permanent effect for hot-humid stress on semen quality can be expected. Recovering of semen quality may be interpreted as an adaptation process (Welch, 1993 and Finzi et al., 1988, 95). It looks obvious that defence mechanisms of the body are efficient against heat stress alone but becomes permanently impaired against the added stress of high relative humidity. This situation necessary means that we are obliged not to use the male bucks in breeding programmes if subjected to similar stress, immediately after the stress ceased. But we have to wait for a period of post treatment recovery. Discussion leads then to conclude that bucks must be protected from high relative humidity in tropical countries. Unluckily this is exactly the opposite of what happens, when air-humidifying systems are utilised to keep a lower environmental temperature.

In **conclusion** it is possible to say that the present results showed that semen quality is extremely sensible to hot-humid stress. After few weeks of hot stress, the bucks are able to produce semen with a good quality, while after the combination of hot and humidity, recovering of semen quality is slow and never reaches to normal values again. This may explain the lowering of fertility in tropical and subtropical countries during the hot months and suggest efficient environment conditioning to reduce production losses during and after the hot periods.

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