

KÁROLY BODNÁR¹, ZSOLT SZENDRŐ², EDIT BIRÓ NÉMETH², CSILLA EIBEN² and ISTVÁN RADNAI²

Comparative evaluation of abnormal spermatozoa in Pannon White, New Zealand White and Angora rabbit semen (short communication)

Dedicated to Professor Dr. Dr. h. c. Gerhard von Lengerken on the occasion of his 65th birthday

Summary

The connection between sperm cell abnormalities and the breeds and seasons was studied. Semen was obtained from 20 Pannon White (PW), 20 New Zealand White (NZW) and 20 Angora (A) males monthly throughout a year. 697 ejaculates were evaluated. The average abnormal spermatozoa content of the ejaculates was 16.07 ± 1.77 , 16.50 ± 0.21 and 27.34 ± 0.30 % respectively. The incidence of head and tail abnormalities was higher than that of other abnormalities in every group, but in A rabbits acrosome abnormalities were also at a significantly high level. The ratio of deformations was higher ($P < 0.05$) in all seasons in the A breed than in PW or NZW. Under Hungarian climate conditions the summer heat causes both primary and secondary degradation in semen quality. The effect of heat stress on spermatogenesis can be observed in the decreased semen quality in autumn.

Key Words: rabbit, New Zealand White, Pannon White, Angora, semen, spermatozoa, abnormalities

Zusammenfassung

Titel der Arbeit: Vergleichende Untersuchung der Spermienanomalien bei Weißen Pannon-, Weißen Neuseeland- und Angora Kaninchen (Kurzmittteilung)

Ziel der Untersuchungen war der Zusammenhang zwischen den Rassen, Jahreszeiten und den Spermienanomalien. Ein Jahr lang wurden monatlich von je 20 Kaninchen der Rassen Weißes Pannon-Kaninchen, Neuseeland-Kaninchen und Angora-Kaninchen 697 Ejakulate untersucht. Der durchschnittliche Anteil an abnormen Samenzellen in den Ejakulaten lag bei $16,07 \pm 1,77$, $16,50 \pm 0,21$ und $27,34 \pm 0,30$ %. Bei den pathologischen Formen traten abnormale Köpfe und Schwänze am häufigsten auf; beim Angora-Kaninchen zeigten sich achrosomatische Anomalien ebenfalls in einem signifikant hohen Wert. Gegenüber den Rassen Weißes Pannon-Kaninchen und Weißes Neuseeland-Kaninchen lag beim Angora-Kaninchen das Verhältnis der Anomalien in allen Jahreszeiten höher ($P < 0,05$). Unter den ungarischen Witterungsverhältnissen verursachte Sommerwärme primäre und sekundäre Veränderungen in der Samenqualität. Die Auswirkung des Wärmestresses auf die Spermatogenese kommt in der verminderten Samenqualität im Herbst zum Ausdruck.

Schlüsselwörter: Kaninchen, Weiße Pannon-Kaninchen, Weiße Neuseeland-Kaninchen, Angora-Kaninchen, Samen, Samenzelle, Anomalie

1. Introduction

Comparison of the semen quality of different breeds provides useful information from both the theoretical and the practical aspect. The data of different authors are often contradictory to each other.

Temperature of 21°C is known as the "comfort zone" for rabbits (FAYEZ et al., 1994).

The rabbit is less tolerant to high temperatures than to low temperatures. If the environmental temperature is above 25-30 °C the behaviour and several physiological parameters change (e.g.: feed consumption, feed conversion, pulse rate, respiration rate). In particular, the respiration rate of Angora rabbits usually increases enormously when the air temperature is above 24 °C for a short period.

VIRÁG et al. (1992) investigated the connection between semen quality and different genotypes and also different production and physiological traits. None of the traits (including season) displayed connections with the percentage of abnormal cells, with the exception of genotype.

In the ejaculates of Bouscat White and New Zealand White males the incidence of sperm abnormalities was higher in summer compared with other seasons, but there was no difference according to breed (AMIN et al., 1987). In contrast to the results of FINZI et al. (1994), unexpectedly, at least some parameters can even improve during acute and chronic heat stress.

Season has a significant effect on semen pH and sperm abnormalities of New Zealand White bucks. Semen pH correlated significantly with the percentage both of primary and of secondary sperm abnormalities. Litter size at birth correlated significantly with semen pH and the percentage of abnormal spermatozoa (JARPA-MENDEZ, 1984.)

RADNAI et al. (1988) found the following incidence of deformations in Angora rabbits: acrosomal lesions 8.5 %, head deformations 10.8 %, plasma droplets 4.6 % and middle piece abnormalities 0.9 %. Data on 180 Angora rabbit ejaculates were evaluated by CARO et al. (1984). Females were inseminated with the semen. Litter size at birth correlated significantly with the percentage of abnormal spermatozoa. COURTENS et al. (1994) found that pregnancy rate correlated negatively with the frequency of acrosome defects in rabbit semen.

The quantitative value and ratio of abnormal forms of spermatozoa is an applicable diagnostic aid for breeders. The objective of the present work was to study the effect of breed and season on the abnormal spermatozoa content of rabbit semen.

2. Material and method

The study to be outlined in this paper was carried out in Kaposvár (Hungary).

Housing. The males were accommodated in individual wire cages. The rabbit house was closed and could be heated in winter (15-16 °C), while the indoor temperature could go up to 25-30 °C during the summer months. The building was aerated by an overpressure ventilation system providing warm air in winter and some cooling in summer. The illumination was partly natural (through windows) following daylength, and partly artificial during working hours.

Feeding and nutrition. The bucks were fed a commercial compound feed (crude protein: 17.1 %, crude fibre: 13.2 %), pelleted in 3 mm pellets and provided *ad libitum*. The ration also included some hay. Drinking water was available from valve type self-drinkers.

The experimental groups. 697 ejaculates were obtained from 20 New Zealand White, 20 Pannon White and 20 Angora rabbits. The distribution of the samples was the following:

Groups	No. of males	No. of ejaculates
New Zealand White (NZW)	20	237
Pannon White (PW)	20	240
Angora (A)	20	220

The age of the bucks was about 8 months at the beginning of the investigation.

Semen collection and evaluation. The semen was obtained monthly by means of artificial vagina. The smear was prepared from the fresh semen on glass slide, then dried at room temperature. The samples were stained with Cerovsky staining (Congo red - gentian violet). The percentage of different deformation types was calculated after the evaluation of 200 spermatozoa per sample.

Statistical analysis of the results was carried out using Analysis of Variance (ANOVA) to compare the means (STATGRAPHICS, 1991).

3. Results and Discussion

The morphological characteristics of semen samples have been summarised in Tables 1-3. The yearly average value of total deformation is significantly higher in the Angora bucks than in the Pannon White and New Zealand White ones by 10 % (Table 1).

Table 1

The mean values of deformation rates of spermia in different breeds ($\bar{x} \pm s. e.$) (Anteil der Spermienanomalien bei den verschiedenen Rassen)

Traits	Groups		
	Pannon White	New Zealand White	Angora
Normally shaped sperm cells %	83.9±1.7 a	83.5±0.2 a	72.7±0.2 b
Abnormal spermatozoa %	16.1±1.8 a	16.5±0.2 a	27.3±0.3 b

Values on the same line with different letters are significantly different ($P < 0.05$).

Apart from normally shaped sperm cells the semen samples contained a varying proportion of grossly abnormal and degenerate spermatozoa representing every deviation (Table 2). The percentages of different types of abnormalities are given in the ratio of the total cell count.

Most of the types of abnormalities showed great individual effect, since the animals responded differently to heat stress (Table 3), this corresponding to the observations of WEITZE et al. (1976).

The incidental rate of acrosome abnormalities was significantly (4-5 times) higher in the Angora group. A considerable difference was found between the ratio of head and tail deformations and that of the other traits, but in the case of New Zealand White a lower rate of tail abnormalities were found. KASA and THWAITES (1992) observed significant increases in the ratio of dead and piriform sperm after an increase in the level of heat stress.

The Pannon White and New Zealand White bucks showed a significantly higher (by 6-10 %) ratio of intact spermatozoa in spring and winter. KADLEČIK (1983) found the same tendency in the Russian breed, but in his opinion the percentages of abnormal spermatozoa also depend on the level of inbreeding in the population. The value of

Table 2

The distribution of deformation types of spermia ($\bar{x} \pm s.e.$) (Verteilung nach Typen der Spermienanomalien)

Forms of abnormalities %	Groups		
	Pannon White	New Zealand White	Angora
Acrosome abnormalities	1.52±0.32 a	1.71±0.18 a	8.24±2.93 b
missing acrosome	0.46	0.68	1.74
inclined acrosome	0.52	0.79	0.74
swollen acrosome	0.47	0.21	4.78
knobbed acrosome	0.07	0.03	0.98
Head abnormalities	5.58±1.69	9.13±1.46	7.26±1.42
piriform head	2.08	2.67	2.60
round head	1.62	1.21	0.49
giant head	0.26	0.75	0.41
small head	0.45	1.54	1.61
double head	0.03	0.01	0.05
elongated head	1.14	2.95	2.1
Abnormalities of the middle piece	0.56±0.21	0.45±0.23	1.14±0.41
double middle piece	0.21	0.26	0.16
retroaxial tail	0.35	0.19	0.98
Cytoplasmic droplets	0.68±0.19	0.42±0.15	1.75±0.45
proximal	0.09	0.06	1.34
distal	0.59	0.36	0.44
Tail abnormalities	7.73±0.57 a	4.79±0.44 b	8.92±0.71 a
single curved tail	2.06	1.40	1.91
hairpin curved tail	4.11	2.32	3.56
coiled tail	1.52	1.03	3.09
Dag-defect	0.03	0.01	0.05
double tail	0.01	0.03	0.31

Values on the same line with different letters are significantly different ($P < 0.05$).

Table 3

Seasonal changes in the incidence of deformation rate ($\bar{x} \pm s.e.$) (Einfluß der Jahreszeiten auf die Häufigkeit von Spermienanomalien)

Seasons	% of abnormalities in groups		
	Pannon White	New Zealand White	Angora
Spring	13.23±1.72 a	14.40±2.11 a	27.09±2.32 a
Summer	20.70±2.03 b	20.40±2.43 b	27.51±3.24 a
Autumn	20.19±2.56 b	20.94±2.67 b	29.85±3.36 a
Winter	10.17±1.58 a	10.28±1.79 a	24.97±2.17 b

Values in the same column with different letters are significantly different ($P < 0.05$).

deformed cells in the winter ejaculates of the Angora group was significantly low compared with other seasons; however, this was some 4-5 % higher than the highest values in the other groups.

4. Conclusions

Our results suggest that Pannon White and New Zealand White males produce less abnormal spermatozoa (about 16 %) throughout the year than Angora bucks (27.3 %). This could be one of the reasons for the unfavourable reproductive performance of the Angora breed.

The mean values of abnormal cells in the Pannon White and the New Zealand White semen were the same, but the distribution of the main types of spermatozoa ab-

normalities were slightly different. Acrosome, head and tail abnormalities showed the highest incidental rate in every group; however, every kind of deformation type was found in the samples. FINZI et al. (1995) developed a method to verify the presence of heat stress in males, based on ratios among different sperm deformations.

In our continental climate both the Pannon white and the New Zealand White samples contained about 5-10 % more abnormal sperm cells in summer and autumn than spring, and winter. Under Hungarian climate the summer heat cause both a primary and secondary degradation in sperm. The effect of heat stress on spermatogenesis can be observed in the decreased semen quality in autumn, since after heat exposure (in summer) the effects disappear by the end of the third spermatogenetic cycle (THARWAT et al., 1994), or more than 70 days are required for recovery (BAGLIACCA et al., 1987).

The high incidence of deformed cells from spring to autumn in Angora semen and the decreased incidence in winter show that this breed has lower tolerance of heat and/or the Angora almost continuously suffers from heat stress, due to its wool. Shearing had no effect on semen quality either in Angora males (BROCKHAUSEN, 1977) or in New Zealand White rabbits (FINZI et al., 1992).

References

- AMIN, S.O.; EL-FOULY, M.A.; EL-SHOBY, H.E.; EL-SHERBINY, A.M.:
Effect of season, breed and sequence of ejaculation on some physical characteristics of rabbit semen. 1st Conference of Agricultural Development Research, Cairo, 1987, vol. 1, 54-67
- BAGLIACCA, M.; CAMILLO, F.; PACI, G.:
The effect of temperature on the reproductive performance of male rabbits. *Rivista di Coniglicoltura*, 24 (1987) 10, 61-65
- BROCKHAUSEN, P.:
Untersuchungen zum Einfluss der Wärmebelastung durch das Wollvlies auf Fruchtbarkeitskriterien männlicher und weiblicher Angorakaninchen. Georg-August Univ. Göttingen, Diss., 1977
- CARO, W.; MAGOFKE, J.C.; GARCIA, X.; GARCIA, G.; CARVAJAL, S.; GECELE, P.; JADRIJEVIC, D.; BRUNA, G.:
Semen characters in rabbits in relation to fertility. *Avances en Investigacion*, 3 (1984), 195-196
- COURTENS, J.L.; BOLET, G.; THEAU-CLEMENT, M.:
Effect of acrosome defects and sperm chromatin decondensation on fertility and litter size in the rabbit. *Reproduction Nutrition Development*, 34 (1994) 5, 427-437
- FAYEZ, I.; MARAI, M.; ALNAIMY, A.; HABEEB, M.:
Thermoregulation in rabbits. 1994, vol. 8, *Rabbit production in hot climates*, 33-41
- FINZI, A.; MORERA, P.; KUZMINSKY, G.:
Effect of shearing on rabbit bucks' performance in hot ambient conditions. *J. Appl. Rabbit Res.*, 15 (1992), 489-494
- FINZI, A.; MORERA, P.; MACCHIONI, P.:
Modifications of some rabbit spermatocytic parameters in relationship to high ambient temperatures. *Cahiers Options Méditerranéennes*, 1994, vol. 8, *Rabbit production in hot climates*, 333-336
- FINZI, A.; MORERA, P.; KUZMINSKY, G.:
Sperm abnormalities as possible indicators of rabbit chronic heat stress. *World Rabbit Science*, 3 (1995) 4, 157-161
- JARPA-MENDEZ, M.:
Semen characters in the rabbit and their relationship with fertility. *Avances Prod. Animal.*, 9 (1984) 1-2, 212-213
- KADLEČIK, O.:
The effect of season and inbreeding on semen quality in rabbits. *Acta Zootechnica*, 39 (1983), 303-309
- KASA, I.W.; THWAITES, C.J.:
Semen quality in bucks exposed to 34 °C for 8 hours on either 1 or 5 days. *J. Appl. Rabbit Res.*, 15 (1992), 560-568

- RADNAI, I.; ZELEI TÓTH, I.; BÁN, B.:
Investigation on semen abnormalities of angora rabbits. 4th World Rabbit Congress, Budapest, 2 (1988), 465-469
- STATGRAPHICS:
STATGRAPHICS (Version 5.0) User Manual. STSC, Inc., Rockville, Maryland, USA, 1991
- THARWAT, E.E.; KHADR, A.F.; AMIN, S.O.; MIUKAWY, M.Y.; KOTBY, E.:
Effect of hot environment on the reproductive performance of New Zealand White rabbit. Cahiers Options Méditerranéennes, 1994, 8, SUPPL, 613-618
- VIRÁG, GY.; MÉZES, M.; BERSÉNYI, A.:
Effect of independent factors on semen characteristics in rabbits. J. Appl. Rabbit Res., 15 (1992), 499-504
- WEITZE, v. F.K.; MÖLLER-HOLTKAMP, P.; STEPHAN, E.:
Auswirkungen experimenteller Wärmebelastung auf einige Ejakulatmerkmale bei Kaninchenböcken. Zuchthygiene 11 (1976), 154-165

Received: 1998-07-21

Accepted: 2000-09-01

Authors' addresses

KÁROLY BODNÁR
University of Szeged, College of Agriculture
P.O.B. 79.
H-6801 Hódmezővásárhely
Hungary

Dr. habil. ZSOLT SZENDRŐ, EDIT BIRÓ NÉMETH, CSILLA EIBEN, ISTVÁN RADNAI
Pannon University of Agricultural Sciences, Kaposvár, Hungary
Guba S. Str. 40.
H-7400 Kaposvár
Hungary