Theses of the PhD dissertation

FACTORS INFLUENCING THE QUALITY OF SHEEP SEMEN

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RESEARCH HISTORY

Among the domestic animals, it is the sheep in which species many of the atavistic qualities are still present, since this species is still the most strongly related to the production environment, the grazing land. Accordingly, in a great percentage of the sheep breeds seasonality has been sustained, which is a barrier to continuous production in numerous cases. Sheep prone to seasonality can be lambed once a year and their fertilization happens in the main breeding season. Their lambs are marketed in the spring and at the beginning of summer, when the supply is the greatest which keeps the prices low.

By now, the application of artificial insemination had dropped in the sheep farms as compared to the previous decades. Insemination of sheep is a biotechnical method hardly applied in commercial farms and is rarely performed even in farms breeding registered animals. Today, the ratio of inseminated ewes does not even reach 2%. The reasons of this undeservedly low number are to be sought primarily in the human factors, as it requires extra labour and stricter discipline, and in the lack of capital.

By a reintroduction of artificial insemination, the number of breeding rams could be reduced, thereby a higher selection pressure could be applied, more uniform stocks of higher production level could be formed.

In the case of rams, the offspring performance test could be performed in greater numbers and with more offsprings, which would enable a more precise estimation of the rams' breeding value. The application of artificial insemination in sheep breeding could considerably accelerate the genetic advancement, in this way the import rams of great value could be better exploited. In the case of home-bred breeds, the endangered ram lines could be saved by gaining more offsprings.

In today's Hungary, whether we aim to breed the current sheep stock or to change the breed, significant development can hardly be achieved in a short time without the application of artificial insemination. This could lead to a significant advancement of the sheep sector, a part of which is a better understanding of the semen production of breeding rams resulting in safer and better conception and finally, in a more profitable production.

I. RESEARCH OBJECTIVES

Presently, more than 90% of the turnover in an average Hungarian sheep farm originates from the sales of live lambs of 20-24 kg weight. This alone would not be a problem, however, the reason for the lack of profit is, that the number of utilized lamb progenies per ewe per year is 0.7-0.8, which does not even cover the production costs. There are also other reasons for the low efficacy: the ageing sheep stock, the unfavourable breed composition, the lack of purposeful crossing, shortcomings of veterinary hygiene and feeding, ageing of the sheepkeepers, the lack of infrastructure, outdated management technology, the lack of innovation and financial resources. As a consequence, the price of the breeding animals is permanently far from their real value, which also discourages the interest in breeding and hinders quality improvement.

From among the deficiencies, the deteriorating breeding efficacy should be mentioned. One of the reasons behind this is that artificial insemination has been totally repressed in the practice of breeding in Hungary. In spite of the fact that this is a tool with which results can be obtained with professionalism, discipline, patience and minimal investment.

Therefore, the reintroduction of the method should be promoted, a better knowledge of the physiology and semen production of rams and the factors influencing the quality of sperms is necessary.

The objectives of my thesis are aimed at the study of the qualitative and quantitative characteristics of ram semen for several breeds. The parameters and freezability of semen and the influencing factors were evaluated with respect to breed, season and condition.

The objectives of the thesis are as follows:

- Do seasons have an impact on the quantitative and qualitative characteristics of sheep semen?

- Does breed have an influence on the parameters of sheep semen?

- What kind of differences can be detected in the qualitative and quantitative characteristics of semen between the home-bred and foreign breed groups?

- By which parameters can the semen of seasonal and aseasonal breed groups be chacaterized?

- Are there differences in the qualitative and quantitative characteristics of semen between the short-tailed, fat-tailed and long-tailed breeds?

- Do the warm days during the different sperm development phases (germinal epithelium, spermatogenesis, maturing in the epididymis) have an impact on the quantitative and qualitative characteristics of semen?

- How does the scrotal circumference vary with the breeds and the season and does it have an effect on semen parameters?

- Do the conformation, the weight, the condition, the thickness of subcutaneous fat and the scrotal circumference influence the volume and quality of semen?

- Is there a change in the rank of rams at different sperm collection dates?

- How many jumpings are necessary for the rams of different breeds for semen collection with artificial vagina?

- Are there relationships between season, jumping order, number of jumpings, the quantitative and qualitative characteristics of semen, and body weight, condition, thickness of subcutaneous fat and scrotal circumference?

II. MATERIALS AND METHODS

Experimental site

Our study was carried out at the Artificial Insemination and Embryo Transfer Station of Awassi Co. at Bakonszeg with Awassi sheep and at the Bábolna Co. Szendrő Gazdaság Ltd. with Suffolk, Ile de France and Babolna Tetra breeds. At the experimental farm of the University of Debrecen Centre of Agricultural Sciences and Engineering, the Prolific Merino, the Tsigai, Barbados Black Belly and Dorper breeds were available for our examinations. Altogether, eight sheep breeds of extreme qualities were studied.

Collection of samples

Semen collection was performed once a week on 4-6 occassions per each season for each breed. The experiments were carried out with trained rams, which were placed in groups separately for each breed. At the evaluation of fresh semen, we determined volume, density, mass motility, percent motility and the pH of the ejaculate. The experimental setup is described in Table 1.

For dilution, we used tris-diluent, the diluted semen was sucked into plastic straw of constant temperature and deep frozen after an equilibration of minimum two hours.

An objective of the experiment was to obtain a realistic picture about the freezability of the tested rams' semen both per season and per breed at farm level. Therefore, all samples in which mass motility was observed were deep-frozen even if they were of very poor quality.

On each occasion, one plastic straw from the frozen sperm was thawed in 40˚C water and evaluated, while another one was tested for heat resistance in a water bath of 46˚C for 30 minutes and was then examined.

The condition of rams was determined, the thickness of fat at the back was determined using an ultrasonic equipment, the body weight and scrotal circumference were measured in each season.

We observed and recorded the sequence of rams as they came out from the group to semen collection and the number of jumpings by the ram before ejaculation. Furthermore, we monitored whether there are changes in the sequence of rams and the number of jumpings before ejaculation at the different dates of semen collection and whether the jumping orders correlate.

In the hottest months of summer, we evaluated the impact of the daily peak temperatures on the quality of the ejaculated semen from the first division of spermatogonia to the appearance of spermatozoa in the ejaculate.

Table 1: Data assessments in the studied breeds

Awassi		Bábolna Tetra, Ile de France, Suffolk		Barbados Blackbelly, Tsigai, Dorper**, Prolific Merino	
date	**parameters**	**date**	**parameters**	**date**	**parameters**
11.10.2007-31.10.2007	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation	10.10.2007-08.11.2007	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation	09.10.2007-07.11.2007	volume, density, mass motility, % motility, pH, ratio of motile cells surviving cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation
31.10.2007	scrotal circumference, thickness of subcutaneous fat, condition, body weight	08.11.2007	scrotal circumference, thickness of subcutaneous fat, condition, body weight *	26.10.2007	scrotal circumference, thickness of subcutaneous fat, condition, body weight
18.12.2007-12.02.2008	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation	20.12.2007-29.01.2008	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation	07.01.2008-13.02.2008	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation
12.02.2008	scrotal circumference, thickness of subcutaneous fat, condition, body weight	29.01.2008	scrotal circumference, thickness of subcutaneous fat, condition, body weight *	13.02.2008	scrotal circumference, thickness of subcutaneous fat, condition, body weight
07.04.2008-29.04.2008	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation	27.03.2008-22.04.2008	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation	11.03.2008-24.04.2008	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation
23.04.2008	scrotal circumference, thickness of subcutaneous fat, condition, body weight	22.04.2008	scrotal circumference, thickness of subcutaneous fat, condition, body weight *	20.04.2008	scrotal circumference, thickness of subcutaneous fat, condition, body weight
01.07.2008-31.07.2008	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation, number of hot days	02.07.2008-05.08.2008	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation, number of hot days	10.06.2008-28.07.2008	volume, density, mass motility, % motility, pH, % motility after cryopreservation, ratio of cells surviving the heat resistance test, jumping order, number of jumpings necessary for ejaculation, number of hot days
08.08.2008	scrotal circumference, thickness of subcutaneous fat, condition, body weight	05.08.2008	scrotal circumference, thickness of subcutaneous fat, condition, body weight *	28.07.2008	scrotal circumference, thickness of subcutaneous fat, condition, body weight

* body weight was not assessed for the breeds Ile de France and Bábolna Tetra, **Assessments were done in the spring and in the summer

Statistical methods

The statistical data evaluation was carried out using the SPSS for Windows 11.0 (SPSS Inc. Chicago, IL.) programme in addition to descriptive statistical methods. The effect of season and breed on semen characteristics were analyzed by correlation analysis. Pearson's correlation and Spearman's correlation were used for quantitative and qualitative parameters, respectively. We analyzed the effect of temperature on semen production by multi-way analysis of variance, the comparison of two-two breed groups by two-sample t-test and the jumping order by rank correlation. The number of jumpings before ejaculation and the changes in jumping order in the tested breeds were evaluated by Chi^2 probe in each season.

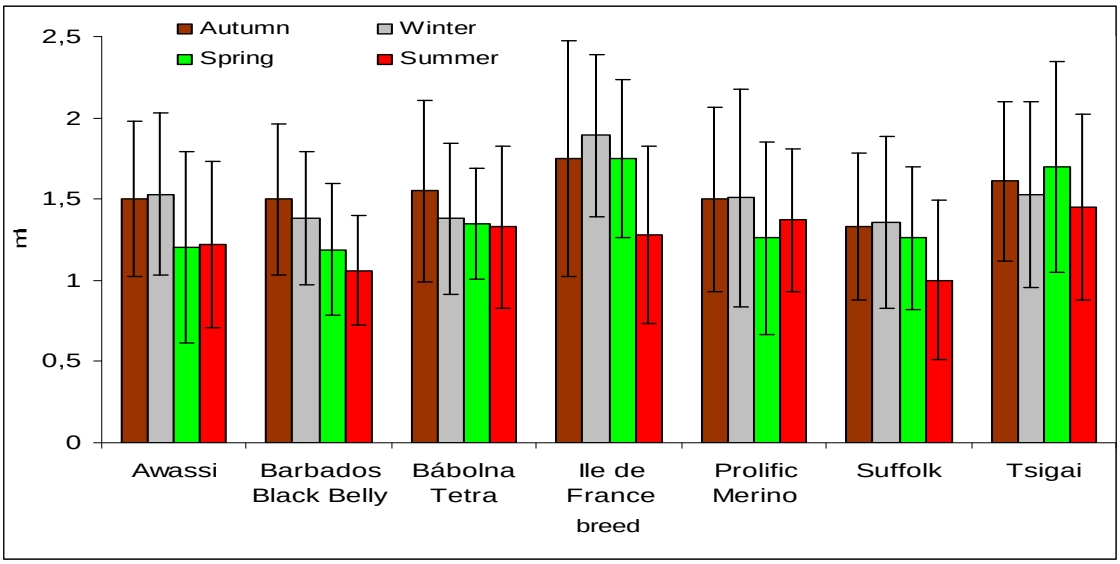
III. MAJOR CONCLUSIONS OF THE THESIS

Study of the quantitative and qualitative characteristics of semen with respect to breed and season

Examination of fresh semen

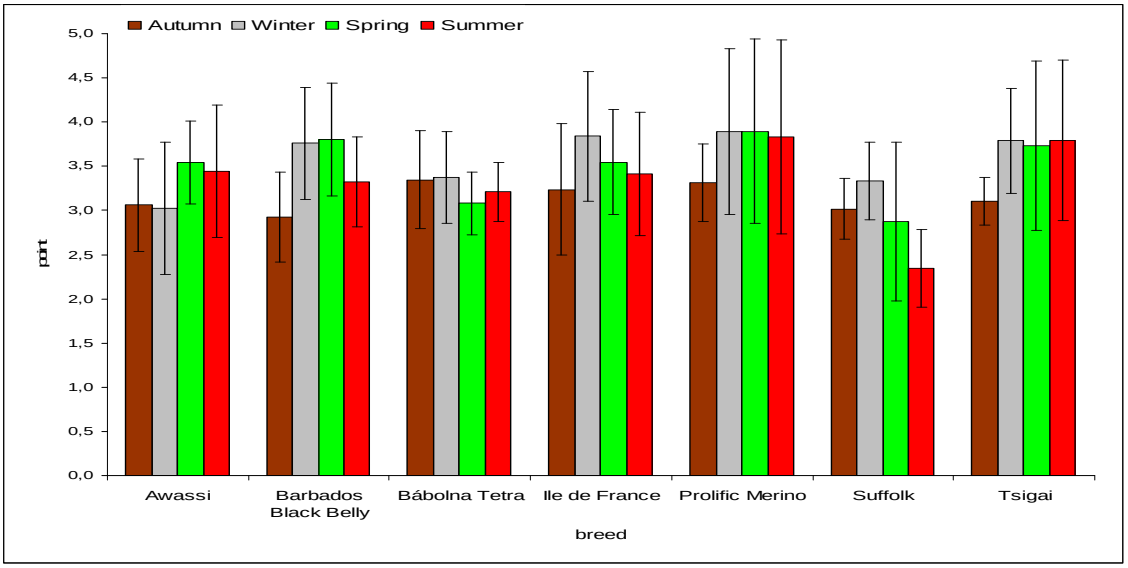
Changes in the amount of semen per breed and season are presented in Figure 1. Semen production of the Ile de France was the best, being the highest in the autumn (1.75 ml), in the winter (1.89 ml) and in the spring (1.75 ml), second only to Tsigai in the summer. The lowest volume of semen was produced by Suffolk in the autumn (1.33 ml), in the winter (1.36 ml) and in the summer (1.0 ml) and by Barbados Blackbelly in the spring (1.19 ml). Attention should be given to the continuous and dramatic decrease in the semen volume of the breed Barbados Blackbelly and the balanced semen production of Bábolna Tetra.

Figure 1: Semen volume per breed and season



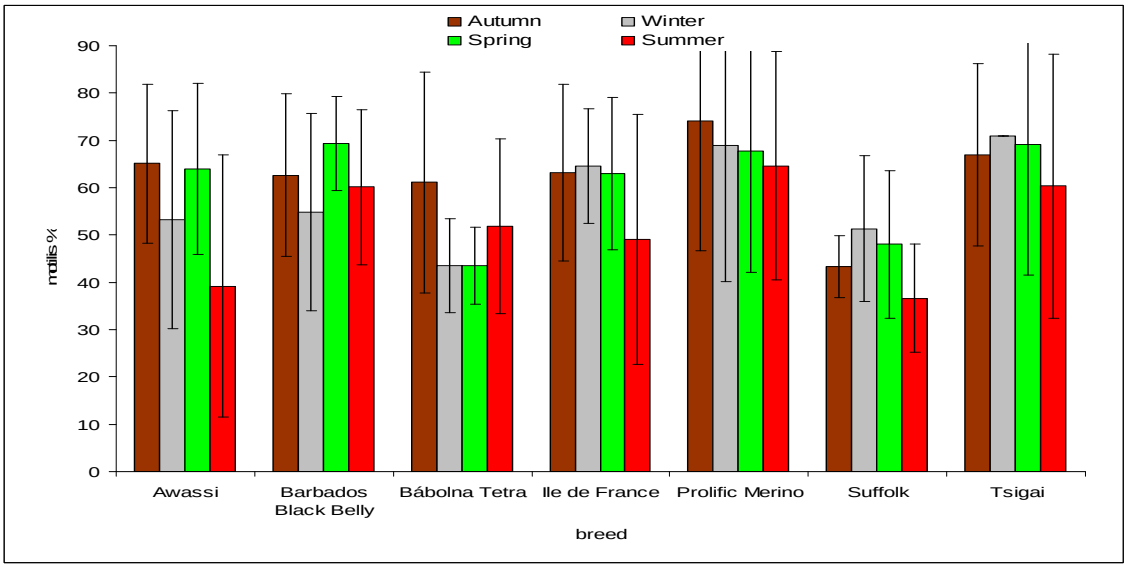
Results of the density examinations are shown in Figure 2. The following data are worthy of discussion. The semen density of Prolific Merino was by far the highest and most balanced. It can be observed, that semen was most dense in the winter and most dilute in the autumn. In An exception was the semen of Suffolk rams which was very watery (2.35) in the summer.
Regarding the mass motility and percent motility of semen, the highest values were measured in the winter for the breeds Tsigai, Ile de France and Suffolk, which were slightly reduced in the spring and the lowest in the summer.

Figure 2: Semen density per breed and season



Percent motility per breed and season is presented in Figure 3. A similar trend was observed for semen mass motility and percent motility.

Figure 3: Changes in the percent of motile spermatozoa in the fresh ejaculate per season and breed



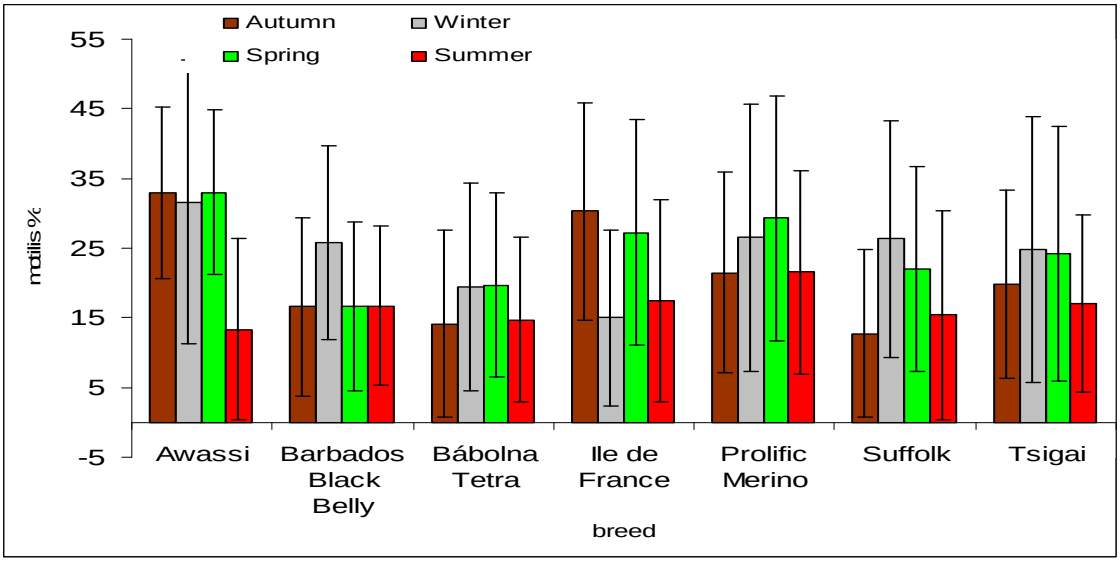
For the breeds Tsigai, Ile de France and Suffolk, both values were the highest in the winter, then slightly reduced in the spring and the lowest in the summer. The following breeds were outstanding in the different seasons: Prolific Merino in the autumn (74%) and in the summer (64%), Tsigai in the winter (71%), Barbados Blackbelly in the summer (69%). The worst

results were obtained from Suffolk rams in three seasons, the percent motility of fresh ejaculates was 37% in the summer and it did not exceed 51% even in the winter.
The pH of the ejaculate of the studied breeds ranged between 7.0 and 7.7 on average.

Analysis of the impact of cryopreservation

After the examinations and the dilution, the semen was deep-frozen using the above-described method. The analysis of the impact of cryopreservation was used for the evaluation of quality changes. After cryopreservation, the sperms in the plastic straws were thawed and the sperms and the percent motility of surviving spermatozoa were examined. We have to highlight that all samples in which mass motility was observed were ceep-frozen even if they were of very poor quality. Therefore, the obtained results cannot be compared with the results of ram semen in commerce produced by the artificial inseminating stations, because there only the best semen is deep-frozen.
Ram sperms show great diversity in their response to freeze-thawing both per season and per breed (Figure 4).

Figure 4: Changes in post-thaw motility of semen per season and breed



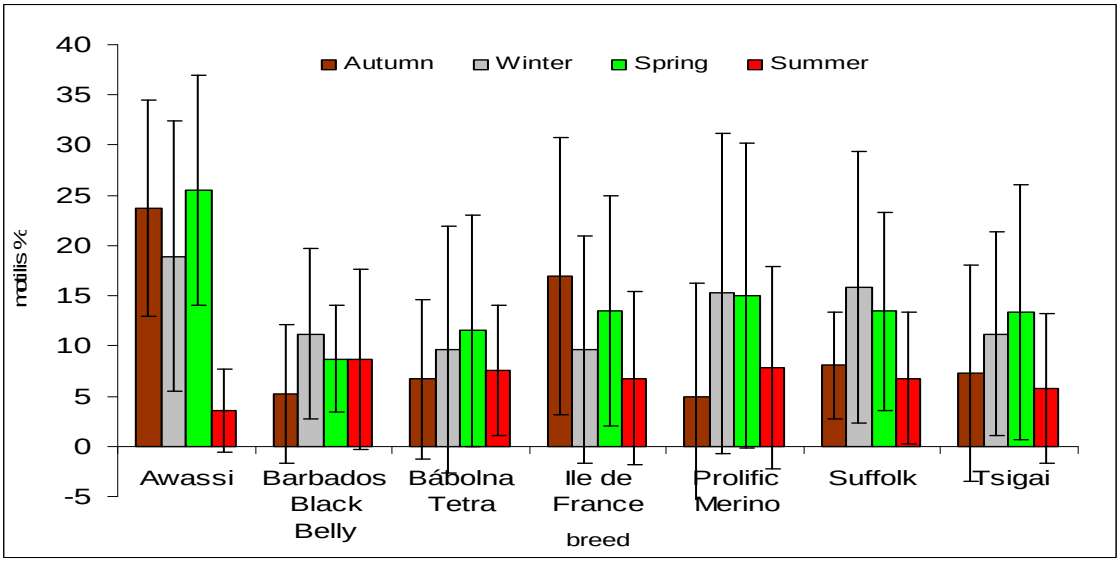
The post-freezing survival rate of sperms from Awassi rams was by far the highest. This does not apply to the parameters collected in the summer. The second best thawing result was measured in Prolific Merino in the winter, in the spring and in the summer. It can be observed

that the semen samples collected from Barbados, Suffolk, Prolific Merino and Bábolna Tetra in the autumn had the lowest tolerance to freezing.

The freezability of semen from Barbados Blackbelly, Tsigai and Suffolk rams was the best in the winter. It is surprising, that for three breeds (Awassi, Bábolna Tetra and Prolific Merino) spring freezing of semen was the most successful, which is not much mentioned in the literature.

Ram sperms were tested for heat endurance after freeze-thawing and the following results were obtained. The Awassi breed showed outstandingly good results except for the summer, when it gave the worst result for heat endurance among all the breeds (Figure 5). When evaluating the seasons, the following trend can be observed:

Figure 5: Heat resistance test results of frozen-thawed semen per season and breed



Out of the studied seven breeds, five gave the highest values in the winter and in the spring. The weakest breeds regarding the heat resistance test were Ile de France in the winter and Barbados Blackbelly in the spring.

The impact of season on ram semen

The quantitative and qualitative characteristics and freezability of semen, results of the heat resistance test, scrotal circumference, condition, thickness of subcutaneous fat and body weight were examined separately for each season.

In all seasons, a significant positive correlation ($p<0.01$) was found between the volume and the density of the fresh ejaculate. An interesting correlation was found between semen volume and density: the larger its volume, the denser it is. This can be explained by the fact that the quality of semen by those rams which give low amounts of semen is weak.

In all seasons, a medium positive significant ($P\leq0.01$) correlation was found between mass motility, percent motility of the fresh ejaculate and density. In all seasons, a very tight significant positive correlation ($P\leq0.01$) was found between mass motility and percent motility of the fresh ejaculate.

In all seasons, a loose positive significant correlation ($P\leq0.01$) was found between mass motility and post-thawing percent motility. In all seasons, a loose positive significant ($P\leq0.01$) correlation was found between percent motility and post-thawing percent motility. Thus, the higher the values of mass motility and percent motility in the fresh ejaculate, the higher the post-thaw percent motility is.

In all seasons, a loose positive significant ($P\leq0.01$) correlation was found between the mass motility of the fresh ejaculate and the percent motility after the heat resistance test. In all seasons, a loose positive significant ($P\leq0.01$) correlation was found between the percent motility of the fresh ejaculate and the percent motility after the heat resistance test.

In all seasons, a tight positive significant ($P\leq0.01$) correlation was found between the post-thawing percent motility and the percent motility after the heat resistance test.

There are positive correlations between the heat resistance test, mass motility, the percent motility of the fresh ejaculate and post-thawing motility, that is sperms respond better to the stress of the heat resistance test, if the progression of fresh sperms is good, the percent motility is high and the post-thawing motility is good.

In all seasons, a medium (tight in the spring) positive significant ($P\leq0.01$) correlation was found between body weight and scrotal circumference. The heavier the ram is, the higher the scrotal circumference is, we suppose that age also has an impact on it.

In all seasons, a medium positive significant ($P\leq0.01$) correlation was found between the thickness of subcutaneous fat and scrotal circumference. In all seasons, a tight positive significant ($P\leq0.01$) correlation was found between the thickness of subcutaneous fat and body weight. The larger the body weight of ram is and the thicker the subcutaneous fat is, the larger the scrotal circumference is.

In the autumn and in the summer, a loose negative significant correlation ($P<0.01$), while in the spring a medium negative significant correlation was found between mass motility of the fresh ejaculate and body weight. In the autumn, in the spring and in the summer, a loose

negative significant (P≤0.01) correlation was found between the thickness of subcutaneous fat and the mass motility of the fresh ejaculate.
In the autumn and in the summer, a loose negative significant correlation (P<0.01), while in the spring a medium negative significant correlation was found between the percent motility of the fresh ejaculaze and body weight. In the autumn, in the spring and in the summer a loose negative significant (P<0.01) correlation was found between the percent motility of the fresh ejaculate and the thickness of subcutaneous fat. Overcondition (large body weight and thick subcutaneous fat) can have a harmful effect on the mass motility of the fresh ejaculate and the percent motility of sperms in the case of semen collected in the autumn and in the spring.

Influence of breed on ram semen

In the case of the Awassi breed, a significant tight positive correlation (p<0.01) was found between heat endurance and freezability of semen, if the spermatozoa responded well to cryopreservation, then their deterioration was low in the heat resistance test.

In the case of the Barbados breed, a significant positive correlation (p<0.01) was found between the mass motility of the fresh ejaculate and its density and between the percent motility of spermatozoa and the density of the ejaculate.

In the case of the Bábolna Tetra breed, there was a significant, very tight positive correlation (p<0.01) between the percent motility of spermatozoa and the mass motility of the ejaculate, the higher the percent motility is, the more vigorous the mass motility is. A significant loose negative correlation (p<0.01) was found between scrotal circumference and semen freezability and between scrotal circumference and the heat resistance test. Semen produced by Bábolna Tetra rams with large scrotal circumference did not endure well the cryopreservation and the heat resistance test. This was different from those observed in the other breeds.

In the case of the Tsigai, Ile de France and Prolific Merino breeds, there was a significant, very tight positive correlation (p<0.01) between the percent motility of spermatozoa and the mass motility of the ejaculate, the higher the percent motility is, the more vigorous the mass motility is.

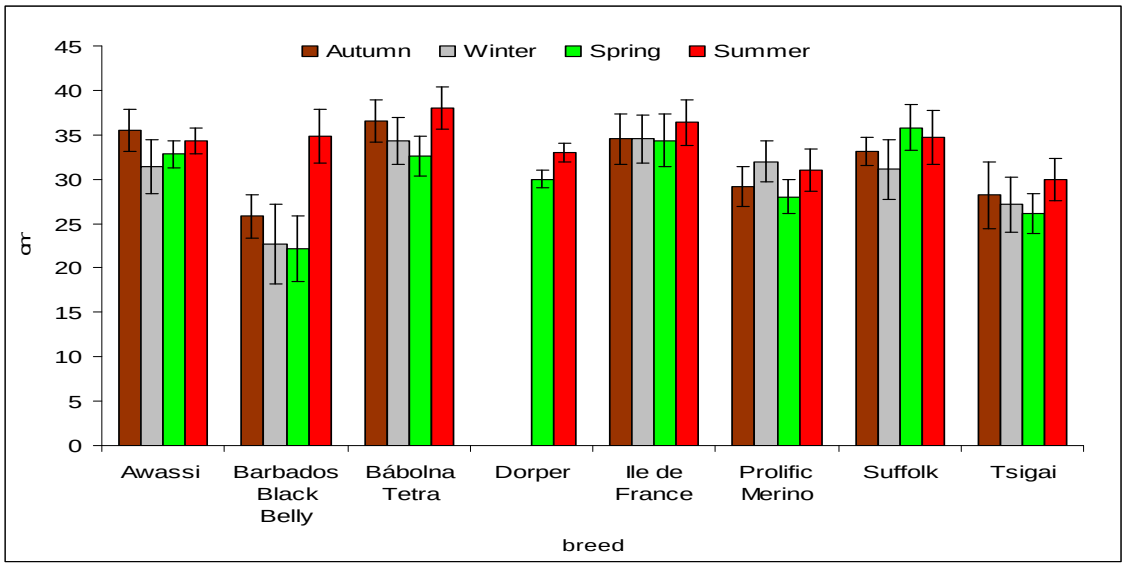
In the case of the Suffolk breed, a significant tight positive correlation ($p<0.01$) was found between the heat resistance test and semen freezability, accordingly, if the spermatozoa responded well to cryopreservation, then their deterioration was low in the heat resistance test. A loose negative correlation ($p<0.01$) was found between the thickness of subcutaneous fat and the volume of the ejaculate and between the thickness of subcutaneous fat and the percent motility of spermatozoa. A thicker subcutaneous fat layer has an unfavourable impact on the volume of the ejaculate and the percent motility of spermatozoa.

Variation in scrotal circumference according to season and breed

The largest scrotal circumference was measured in the autumn for the Awassi (35.5 cm), in the spring for the Suffolk (35.8 cm) and in the winter for the Prolific Merino (32 cm) (Figure 6).

For the other breeds studied, the largest values were measured in the summer. The smallest scrotal circumference values were measured for the Barbados Blackbelly breed during the examination period (in the autumn: 26 cm, in the winter: 23 cm, in the spring: 22 cm, except for the summer (35 cm), by which time it increased by 12.5 cm. There was hardly any change in the scrotal circumference of the Ile de France rams during the whole year.

Figure 6: Changes in the scrotal circumference according to season and breed



The impact of temperature on the semen production by rams

The number of warm days (>26 ^{o}C) in the germinal epithelium phase showed a significant correlation (P≤0.05) with the pH of the fresh ejaculate, the percent motility of the frozen-thawed spermatozoa and the heat resistance test (P≤0.001). The number of warm days during spermatogenesis showed a significant correlation (P≤0.05) with the pH of the fresh ejaculate, the percent motility of the frozen-thawed spermatozoa and the heat resistance test. The number of warm days during the maturing in the epididymis showed a significant correlation (P≤0.05) with the heat resistance test and a tendency could be observed with the freezability of semen.

Table 1. The effect of the number of warm days during the different sperm development phases on the different quality parameters of semen

Quality	Breed	Germinal epithelium	Spermatogenesis	Epididymis
volume	***	n.s.	n.s.	n.s.
density	***	n.s.	n.s.	n.s.
mass motility	***	n.s.	n.s.	n.s.
% motility	***	n.s.	n.s.	n.s.
pH	***	*	*	n.s.
thawed heat endurance	***	*	*	+
	+	**	*	*

Legend: P≤0.001***; P≤0.05*; P≤0.001**; P≤0,1 + , n. s.: non-significant

Study of the jumping order

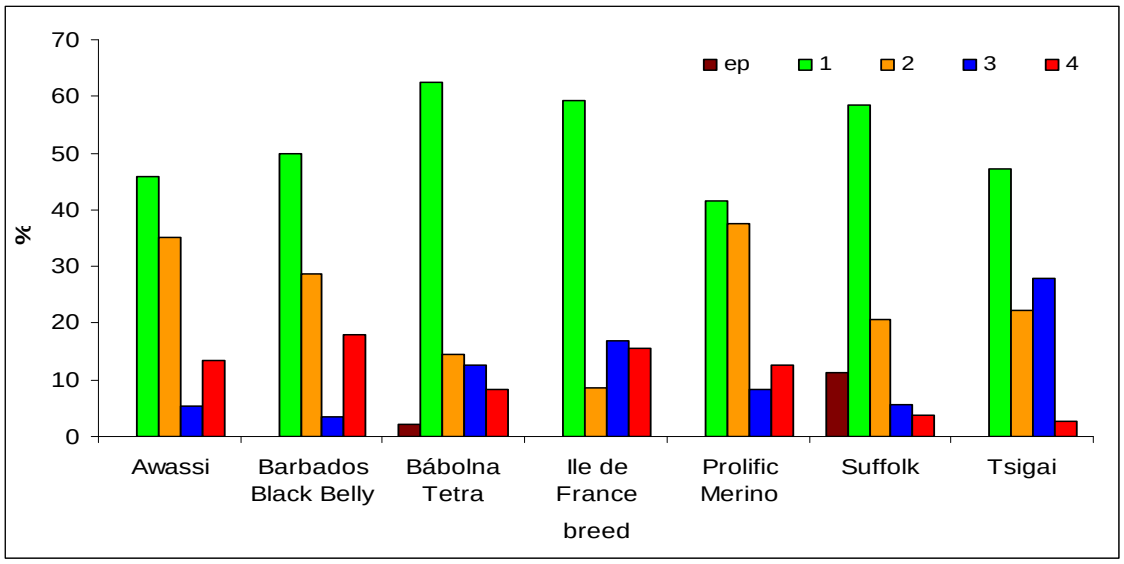
We observed and recorded whether there had been a change in the jumping order of rams at different semen collection dates. By using rank correlation, we found that when the jumping orders of the studied breeds at two different jumping days were compared, the degree (loose, tight, very tight) and sign (negative, positive) of correlation varied with the breed.

Examination of the number of jumpings necessary for ejaculation

When observing the number of jumpings necessary for ejaculation, the following results were obtained:

The percentage of rams ejaculating at the first jumping in the different breeds was 59% for Suffolk, 63% for Bábolna Tetra, 59%-a for Ile de France, 46% for Awassi, 50 % for Barbados Blackbelly, 47% for Tsigai and 42% for Prolific Merino rams.

Figure 7: The ratio of jumpings necessary for ejaculation in the studied breeds



Ejaculation for the second jumping, which is general at natural mating, occurred in 38% of the Prolific Merino rams, 29% of Barbados Blackbelly rams, 22% of Tsigai rams, 15 % of Bábolna Tetra rams, 35% of Awassi rams, 20% of Suffolk rams and 9% of Ile de France rams (Figure 7). Ejaculatio praecox (ep) occurred in only a small ratio (2%) of the Bábolna Tetra rams, while in the case of Suffolk rams, its frequency was 11%.

The number of jumpings necessary for ejaculation was analysed by a test for independence and we found a correlation between the number of jumpings and the breed, the number of jumpings differed between the breeds.

In the case of the Awassi breed, there was a very tight significant negative correlation ($p<0.01$) between the mass motility of the ejaculate and the rank, that is the later the ram comes out for semen collection, the better the mass motility of the semen is.

In the case of the Bábolna Tetra breed, there was a significant tight positive correlation ($p<0.05$) between the heat resistance test in the summer and the number of jumpings necessary for ejaculation, that is if the ram needed several jumpings before ejaculation, the result of the heat resistance test was better.

In the case of the Ile de France breed, a significant tight negative correlation ($p<0.01$) was found in the winter between the mass motility and the jumping order. When coming out for semen collection in the winter, the semen of the rams at the bottom of the rank had better mass motility.

In the case of the Suffolk breed, a significant tight positive correlation ($p<0.05$) was found in the winter between condition and rank, that is the better the condition of the ram is, the better position it has in the jumping order. In the summer, there was a significant tight negative correlation ($p<0.01$) between the mass motility of the ejaculate and the rank. When coming out for semen collection by artificial vagina, the mass motility of the semen of rams at the top of the rank is lower.

IV. NEW SCIENTIFIC RESULTS OF THE THESIS

From the results of the performed analyses, the new scientific results of my thesis are as follows:

1. With my new data, I contributed to the determination of differences in the quantitative and qualitative parameters of fresh and frozen-thawn semen of rams belonging to different breeds. The results help the selection of optimum semen collection dates. The semen volume was the largest in winter for the breeds Awassi (1.53 ml), Ile de France (1.89 ml), Suffolk (1.36 ml) and Prolific Merino (1.51 ml), while the highest values were measured in the autumn for Barbados Black Belly (1.5 ml) and Bábolna Tetra (1.55 ml) and in the spring for Tsigai (1.7 ml): The percent motility in the fresh ejaculate was the best in the autumn for the breeds Awassi (65%), Bábolna Tetra (61%) and Prolific Merino (74%), while the best values were obtained in the winter for Tsigai (71%), Ile de France (65%) and Suffolk (51%) and in the spring for Barbados Black Belly (69%): Via the breed classifications, I contributed to the estimation of the semen parameters of the breeds imported to Hungary. The measured data are available for the short-tailed breed group for example, which enable us to draw conclusions regarding the semen production of a short-tailed breed imported to Hungary.

2. I concluded that overcondition (large body weight and thick subcutaneous fat) has a harmful effect on the mass motility and percent motility of the fresh ejaculate.

3. I revealed that the qualities of semen from the studied rams of belonging to different genotypes differ among the seasons, the largest differences in quality and quantity were observed between the breeds Awassi and Suffolk.

4. I found that semen quality of seasonal and aseasonal breeds changes differently during the course of the year and seasons have a modifying effect in it. In all seasons, semen production is higher in the aseasonal group; the largest difference between the two groups was measured in the autumn. Regarding density, the semen of the aseasonal groups was better except for the autumn. In the course of the whole year, mass motility was better in the aseasonal group, the largest difference between the two groups was observed in the summer.

5. I revealed the differences in the number of jumpings before ejaculation between the breeds by semen collection with artificial vagina. The ratio of rams ejaculating at the first jumping was 59% for Suffolk, 63% for Bábolna Tetra, 59% for Ile de France, 46% for Awassi. 50% for Barbados Black Belly, 47% for Tsigai and 42% for Prolific Merino.

6. I found that the optimum time for ram semen cryopreservation is breed-specific in Hungary. The optimal dates for semen cyropreservation are in the autumn for Ile de France, in the winter for Suffolk and in the spring for Prolific Merino.

V. PRACTICAL APPLICABILITY OF THE RESULTS

1. The basis of continuous lamb production is a stable semen production of good quality throughout the whole year. From among the studied breeds, two breeds are the most suitable for this, Ile de France and Prolific Merino.

2. I found that the semen of Awassi rams was the least damaged by cryopreservation.

3. The success of artificial insemination is influenced, via the quality of semen, by the season of sperm collection and the number of warm days during spermatogenesis. When selecting the mating dates, it should be avoided that either oestrus or semen quality is of low-level. Table 33 is of assistance in this matter.

Table 33: Semen collection dates for the studied breeds for fresh and cryopreserved semen

Breed	**most favourable season**	
	Fresh ejaculate, in percent motility	**For cryopreservation**
Awassi	autumn	autumn
Barbados Black Belly	spring	winter
Bábolna Tetra	autumn	spring
Tsigai	winter	winter
Ile de France	winter	autumn
Suffolk	winter	winter
Prolific Merino	autumn	spring

4. I found that the more dense the ejaculate, the better its mass motility and percent motility are.

5. The better the mass motility and percent motility of the fresh ejaculate are, the higher the the post-thawing percent motility was and the sperms responded better to the heat resistance test.

6. In my research, I concluded that a larger body weight and thicker subcutaneous fat are accompanied by a larger scrotal circumference.

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