Kafkas Univ Vet Fak Derg
22 (2): 225-232, 2016
DOI: 10.9775/kvfd.2015.14229

Kafkas Universitesi Veteriner Fakultesi Dergisi
Journal Home-Page: http://vetdergi.kafkas.edu.tr
Online Submission: http://vetdergikafkas.org

Research Article

Effect of Piggery Microclimate on Ejaculate Performance of Artificial Insemination Boars

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Article Code: KVFD-2015-14229 Received: 13.08.2015 Accepted: 25.11.2015 Published Online: 02.12.2015

Abstract

The study was carried out on 1913 ejaculates collected from 51 Landrace boars. The ejaculates were collected manually. The study included all ejaculates collected by one artificial insemination station over a span of 12 consecutive months. The ejaculates were subjected to the standard analysis which involved: ejaculate volume, sperm concentration, percentage of progressive motility spermatozoa, total number of spermatozoa, and number of artificial insemination doses per ejaculate. Temperature, relative air humidity, and atmospheric pressure in the piggery were monitored during the semen collections. The resulting data were grouped by air temperature, humidity and pressure, and analyzed. It has been found that the microclimate in the place of semen collection may affect the quality of the collected semen. This effect is varied; temperature, humidity and atmospheric pressure act differently in relation to the semen traits. Temperature and atmospheric pressure have an effect on sperm concentration. Ejaculates with the highest sperm concentrations were collected at the lowest measured temperatures (10°C and lower) as well as with the lowest relative air humidity. Sperm motility revealed a strict and oriented relationship with both temperature and humidity, but also with atmospheric pressure. Semen collected at the lowest air humidity (50% and lower) and at the lowest observed atmospheric pressure (below 900 hPa) contained the most sperm. The highest number of artificial insemination doses are produced from ejaculates collected in such conditions.

Keywords: *Microclimate, Semen quality, Artificial insemination boars*

Mikro Klima İklim Şartlarının Erkek Damızlık Domuzlardaki Ejekulasyon Kalitesine Etkileri

Özet

Araştırma Landrace cinsi 51 erkek damızlık domuzdan alınan 1913 ejekulasyonda gerçekleştirilmiştir. Numuneler el yöntemiyle alınmıştır. Ejekulasyonlar sonraki 12 ay süresince uygulanacak yapay döllenme için tek bir domuz yetiştirme istasyonundan elde edilmiştir. Standart tahliller olan, semen hacmi, spermlerin konsantrasyonu, hareketli sperm sayısının oranı, toplam sperm sayısı ve yapay döllenmedeki doz sayısı analizleri yapılmıştır. Semen örneği alımı sırasında damızlık hayvanların bulundupu yerdeki atmosfer basıncı, havadaki nem ve sıcaklık durumu izlenmiştir. Elde edilen veriler, sıcaklık, nem ve hava basıncına göre gruplandırılmış vede tekrar analiz edilmiştir. Bu çalışmalar neticesinde damızlık hayvanların tutulduğu yerdeki mikro klima şartlarının semen kalitesine etkisi olabileceği görülmüştür. Sıcaklık, nem ve atmosfer basıncı sperm özelliklerine farklı biçimde etki etmektedir. Sıcaklık ve atmosfer basıncı spermlerin konsantrasyonunu doğrudan etkilemektedir. En yüksek sperm konsantrasyonu bulunan ejekulasyonlar, havaya göre en düşük nem ortamı vede en düşük sıcaklıkta (10°C ve aşağısı) elde edilmiştir. Sperm motilitesinin hava basıncı, nem ve sıcaklığa doğrudan bağlı olduğu ortaya çıkmıştır. En fazla sayıda sperm miktarı, en düşük nem oranlarında yani %50 ve daha azı ile 900 hPa hava basıncı şartlarında sağlanmıştır. Bu şartların hakim olduğu ortamlarda hayvanlardan alınan ejakulasyonlardan yapay döllenmeler için gerekli en fazla sayıda elde edilmiştir.

Anahtar sözcükler: *Mikroklima, Sperm kalitesi, Damızlık erkek domuz*

INTRODUCTION

Artificial insemination (AI) plays an important role in swine production and brings numerous advantages; it enables an efficient use of sires, facilitates the organization of breeding in the herd, and reduces the risk of spreading infectious diseases [1]. The main criterion of boars selection for AI centers is the breeding value of the boar, which

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is usually much higher than the average of a given population of young boars classified for evaluation [2]. The economic viability of an AI boar does not depend much on its breeding value though. The decisive factor is the ejaculatory performance, which is the number of AI doses obtained per ejaculate. It is important that the boar shows the ability to produce ejaculates of rather equal quality throughout its lifetime [3]. Therefore, the aim is to use the boars that demonstrate outstanding ejaculate traits, i.e. a large volume of discharged semen with a high concentration and good motility of sperm [4].

Numerous studies demonstrate that the quality and quantity of semen depend on a complexity of factors. These include genetics, primarily the breed of the boar [5,6]. Crossbred boars, which attain sexual maturation sooner, grow faster and have a better breeding performance, as compared with pure-bred pigs, have found a wide application in artificial insemination [7]. Other than genetic factors also affect boar performance, and these include boar's age [8], year season [9,10], changing photoperiod [11], feeding [12], as well as the time interval between ejaculations [13]. It has been found that ejaculation performance in boars is also related with the size of the testes [14]. Such a variety of genetic and environmental factors, as well as interactions between them, result in extremely varied ejaculates of AI boars, which complicates their efficient management. This study is an attempt to evaluate the effect of air temperature, relative humidity, and atmospheric pressure during semen collection on the physical traits of ejaculates of artificial insemination boars.

MATERIAL and METHODS

All boars were fed commercial food for AI boars and were housed in individual pens equipped with nipple drinkers. The boars were maintained in accordance with the principles of animal welfare [15]. Ethics committee approval for this study was given by the Decision of the District Veterinary Officer (14262001). In the study air temperature, relative humidity and the atmospheric pressure on the moment of semen collection were measured. Temperature and humidity was recorded using a thermo-hygrometer TERMIK PLUS (1000209, Termo-produkt, PL). Temperature was measured with a precision of one degree Celsius. Humidity, expressed as a percentage, was measured with a precision of one percent point. Atmospheric pressure was measured using an barometer ADLER (Bar 003, Demus, PL) with a resolution one hPa.

The temperature and humidity sensors, as well as the barometer, were placed in the central part of the piggery, halfway in the aisle dividing the facility into two equal parts. The readings were taken during the semen collection from each boar. The analysis included 1913 ejaculates obtained from 51 Landrace boars. The semen was collected using the gloved-hand technique, using a clean semen collecting flask that filters out gel, dust, and bristles [16]. The evaluation included all ejaculates collected over the period of 12 consecutive months. In order to evaluate the effect of the facility microclimate on the semen quality, each ejaculate was subjected to standard analysis of the following physical traits: ejaculate volume, sperm concentration, percentage of spermatozoa showing progressive motility, the total number of spermatozoa, and the number of insemination doses per ejaculate. Ejaculate volumes were determined by weight, without the gelatinous fraction, using electronic scales. Sperm concentration in the ejaculates was determined with a photometric method, using a spectrophotometer (IMV Technologies, France). Sperm motility was evaluated with a Nikon Eclipse 50i light microscope equipped with a heated stage. A sample of 5 µl of sperm suspension was placed on a pre-warmed slide and sealed with a coverslip at 37ºC. Under 200x magnification, the percentage of normally motile spermatozoa was determined in the overall number of sperms present in the field of vision of the microscope. The total number of motile spermatozoa and the number of insemination doses per ejaculate were calculated using SYSTEM SUL (v. 6.35; Gogosystem, Poland) software package.

In order to evaluate the effect of air temperature, ejaculates were assigned to the following four groups:

Group I : Ejaculates collected at a temperature up to 10°C
Group II : Ejaculates collected at a temperature 11-15°C
Group III : Ejaculates collected at a temperature 16-20°C
Group IV : Ejaculates collected at a temperature above 20°C

In order to evaluate the effect of air relative humidity, the ejaculates were assigned to the following six groups:

Group I : Ejaculates collected at an air humidity up to 50%
Group II : Ejaculates collected at an air humidity 51-55%
Group III : Ejaculates collected at an air humidity 56-60%
Group IV : Ejaculates collected at an air humidity 61-65%
Group V : Ejaculates collected at an air humidity 66-70%
Group VI: Ejaculates collected at an air humidity above 70%

In order to evaluate the effect of atmospheric pressure, the ejaculates were assigned to the following six groups:

Group I: Ejaculates collected at an atmospheric pressure up to 990 hPa
Group II: Ejaculates collected at an atmospheric pressure 991-995 hPa
Group III: Ejaculates collected at an atmospheric pressure 996-1000 hPa
Group IV: Ejaculates collected at an atmospheric pressure 1001-1005 hPa
Group V: Ejaculates collected at an atmospheric pressure 1006-1010 hPa

Group VI: Ejaculates collected at an atmospheric pressure above 1010 hPa

The resulting data were processed statistically according to the following model:

$Y_{ij} = \mu + a_i + e_{ij}$

where:

Y_{ij} - factor level,

μ - population mean,

a_i - effect of air temperature, humidity or atmospheric pressure,

e_{ij} - error.

The significance of differences between the groups was tested using the Tukey test.

RESULTS

Table 1 presents the data on physical characteristics of the ejaculates in relation to air temperature measured at semen collection. The data reveal that nearly 70% of ejaculates were collected at the range 11-20°C.

The data of *Table 1* reveal that the ejaculates of Group II had the lowest ejaculate volume (P<0.01). Ejaculates collected at temperature up to 10°C (Group I) showed a higher sperm concentration by 19 x10^3/mm^3 compared with those collected at 11°C or higher (Groups II-IV, P<0.01). The data shown in *Table 1* indicate a distinct relationship between motility and air temperature at semen collection. Sperm motility in ejaculates increased with air temperature they were collected at. The highest sperm motility was found in ejaculates collected at temperature above 16°C (Groups III and IV). It exceeded 72.75% and was by more than 1.5% higher than in the semen collected at 11-15°C (P<0.01) and by more than 2.7% higher compared to those collected below 10°C (P<0.01).

No clear relationship has also been found between the number of insemination doses and air temperature at semen collection *(Fig. 1)*. The average was approx. 24.61-25.05 insemination doses obtained from an ejaculate (Groups I, III and IV), but Group II (11-15ºC) was an exception; these ejaculates gave by more than 1.5 fewer doses (P<0.05).

Table 2 presents data on the physical characteristics of ejaculate, depending on the relative humidity recorded

Table 1. *Relationship between ejaculate physical characteristics and air temperature in the piggery during ejaculate collection*
Tablo 1. *Ejakulat toplanması esnasında domuz ahırındaki hava sıcaklığı ile ejakulatın fiziksel özellikleri arasındaki ilişki*

Specification		Air Temperature in the Piggery (°C) (Groups)			
		I (≤10°C)	II (11-15°C)	III (16-20°C)	IV (>20°C)
Average air temperature during ejaculates collection (°C)		9.05	12.89	18.17	22.54
Number of ejaculates	n	409	747	564	193
Ejaculate volume (ml)	X±Sx	241.93±86.78^B	234.71±75.36^A	243.63±84.72^B	244.00±84.34^B
Sperm concentration (x 10^3/mm^3)	X±Sx	398.56±103.98^B	375.33±94.14^A	379.49±90.55^A	378.86±95.26^A
Percentage of spermatozoa with progressive motility (%)	X±Sx	70.00±0.00^A	71.23±3.29^{AB}	72.77±4.48^B	72.75±4.47^B
Total sperm count per ejaculate (x 10^9)	X±Sx	64.09±20.23^b	60.82±19.79^a	64.16±18.97^b	64.4420.41^b
Number of insemination doses	X±Sx	24.61±7.97^b	23.97±7.58^a	25.05±7.15^b	24.82±7.58^b

^{a,b} Differences between average values, represented by different letters in the same row, is important (P<0.05); ^{A,B} Differences between average values, represented by different letters in the same row, is important (P<0.01)

Fig 1. Monthly distribution of temperatures during semen collection (number of days in each month when semen was collected at a specific temperature)

Şekil 1. Semen toplanması boyunca sıcaklığın aylara göre dağılımı (belli bir sıcaklıkta semen toplandığında her aydaki günlerin sayısı)

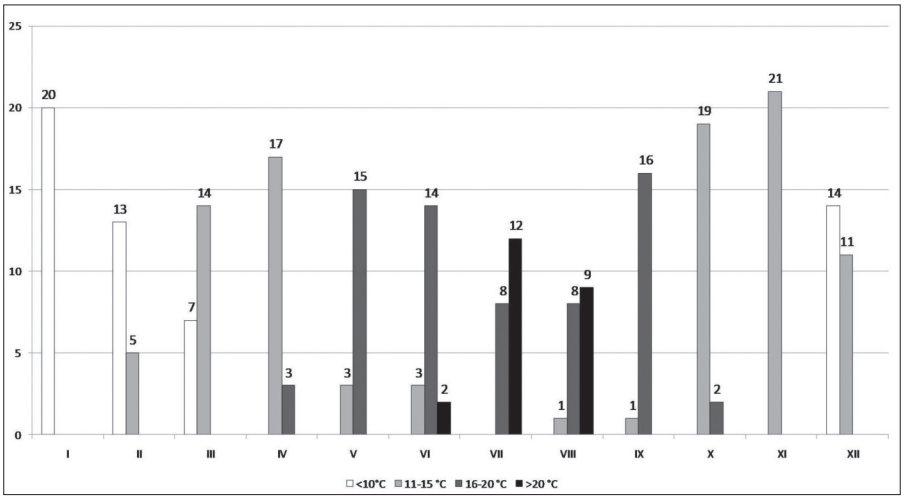

Table 2. *Relationship between ejaculate physical characteristics and air relative humidity in the piggery during ejaculate collection*
Tablo 2. *Ejakulat toplanması esnasında domuz ahırındaki nem ile ejakulatın fiziksel özellikleri arasındaki ilişki*

Specification		Air Relative Humidity in the Piggery (%) (Groups)					
		I (≤50%)	II (51-55%)	III (56-60%)	IV (61-65%)	V (66-70%)	VI (>70%)
Average air relative humidity during ejaculates collection (%)		44.52	53.32	58.44	63.58	68.62	172
Number of ejaculates	n	446	395	437	325	138	172
Ejaculate volume (ml)	X±Sx	230.90±79.43^{A}	233.93±83.35^{AB}	250.17±80.34^{C}	238.73±82.30^{B}	251.96±82.23^{C}	242.52±82.04^{BC}
Sperm concentration (x 10^3/mm^3)	X±Sx	412.91±96.94^{C}	382.48±95.63^{B}	367.73±89.39^{AB}	378.09±95.15^{B}	351.23±87.44^{A}	367.67±96.60^{AB}
Percentage of spermatozoa with progressive motility (%)	X±Sx	71.14±3.19^{A}	71.65±3.71^{B}	71.17±3.21^{A}	71.85±3.89^{B}	72.32±4.24^{B}	72.44±4.31^{B}
Total sperm count per ejaculate (x 10^9)	X±Sx	65.22±20.72^{c}	61.51±20.82^{ab}	62.66±18.33^{ab}	62.52±19.66^{ab}	60.59±16.98^{ab}	62.95±20.21^{ab}
Number of insemination doses	X±Sx	25.06±8.15	24.15±7.68	24.46±7.05	24.55±7.62	24.23±6.42	24.22±7.58

^{a,b} Differences between average values, represented by different letters in the same row, is important (P<0.05); ^{A,B} Differences between average values, represented by different letters in the same row, is important (P<0.01)

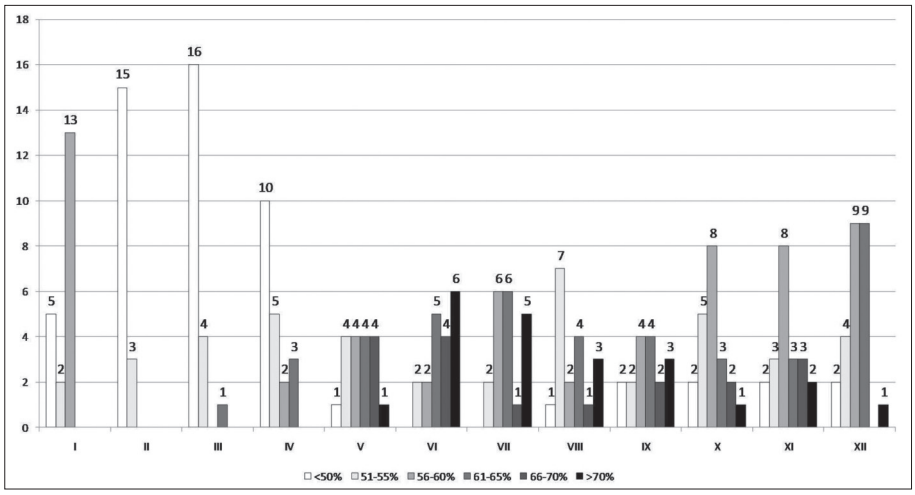

Fig 2. Monthly distribution of relative humidities during semen collection (number of days in each month when semen was collected at a specific humidity)

Şekil 2. Semen toplanması boyunca nemin aylara göre dağılımı (belli bir nemde semen toplandığında her aydaki günlerin sayısı)

during the collection. These data show that ejaculates of the greatest volume were collected at a relative humidity of 66-70%. The volume exceeded 251 ml and was higher by 21.06 ml than in those collected at a humidity not exceeding 50% (P<0.01) and by more than 18 ml higher than in those collected at a relative humidity of 51-55% (P<0.05). Ejaculates collected at a relative humidity equal or lower than 50% (Group I) had a higher concentration of sperm, by 30 x10^3/mm^3, as compared with ejaculates collected at a relative humidity of 51% or higher (Groups II, III, IV, V and VI; P<0.01).

The highest sperm motility was found in ejaculates collected at a relative humidity above 70%. It exceeded 72.4% and was higher by more than 1.27% compared to those collected at 56-60% (P<0.01) and by 1.3% higher than in those collected at a relative humidity not exceeding 50% (P<0.01). Ejaculates collected at very low relative humidities (below 50%) contained the most sperm. Sperm counts in these ejaculates averaged 65.22 billion, by 2.27-4.63 billion more than in those collected at higher humidity (Group II, III, IV, V and VI). No relationship was found between the number of insemination doses and air relative humidity. The average number of insemination doses obtained from the ejaculate was about 24.15-25.06 *(Fig. 2)*.

Table 3 presents the data on physical traits of the semen in relation to the atmospheric pressure measured at the moment of ejaculation. Group VI, with the highest atmospheric pressure, was found to have the lowest ejaculate volume. It exceeded 232 ml and was by about 10.3 ml less than those collected at 991-995 hPa (P<0.01) and by about 11.5 ml less than in ejaculates collected at 1001-1005 hPa (P<0.01).

Ejaculates collected at the lowest atmospheric pressure (not more than 990 hPa, Group I) had the highest sperm concentration. The concentration of sperm decreased as atmospheric pressure increased to 996-1000 hPa (Group III). Ejaculates collected in this group had the lowest sperm concentration, by about 21 x10^3/mm^3 less than those collected at a pressure below 990 hPa (P<0.05). A further increase in atmospheric pressure resulted in an increase

Table 3. *Relationship between ejaculate physical characteristics and atmospheric pressure in the piggery during ejaculate collection*
Tablo 3. *Ejakulat toplanması esnasında domuz ahırındaki atmosferik basınç ile ejakulatın fiziksel özellikleri arasındaki ilişki*

Specification		Atmospheric Pressure in the Piggery (hPa) (Groups)					
		I ≤990 hPa	II 991-995 hPa	III 996-1000 hPa	IV 1001-1005 hPa	V 1006-1010 hPa	VI >1010 hPa
Average atmospheric pressure during ejaculates collection (hPa)		981.56	993.26	998.61	1004.10	1007.87	1015.35
Number of ejaculates	n	137	153	316	632	474	201
Ejaculate volume (ml)	X±Sx	239.90±84.21^{B}	242.63±84.22^{BC}	234.67±77.32^{AB}	243.83±83.77^{C}	240.16±81.52^{BC}	232.32±78.13^{A}
Sperm concentration (x 10^3/mm^3)	X±Sx	395.69±95.09^{c}	380.78±101.25^{ab}	374.87±97.78^{a}	376.82±94.90^{a}	385.34±94.00^{b}	392.04±94.52^{bc}
Percentage of spermatozoa with progressive motility (%)	X±Sx	70.00±0.00^{A}	71.05±3.07^{B}	71.52±3.59^{B}	71.99±4.00^{B}	71.48±3.55^{B}	72.04±4.04^{B}
Total sperm count per ejaculate (x 10^9)	X±Sx	64.07±19.87^{b}	62.65±19.86^{ab}	59.94±19.11^{a}	63.46±20.20^{b}	63.45±19.10^{b}	63.60±20.62^{b}
Number of insemination doses	X±Sx	25.23±8.56^{b}	24.94±7.90^{a}	23.83±6.79^{a}	24.41±7.54^{a}	24.83±7.30^{a}	24.97±8.17^{a}

^{a,b} Differences between average values, represented by different letters in the same row, is important (P<0.05); ^{A,B} Differences between average values, represented by different letters in the same row, is important (P<0.01)

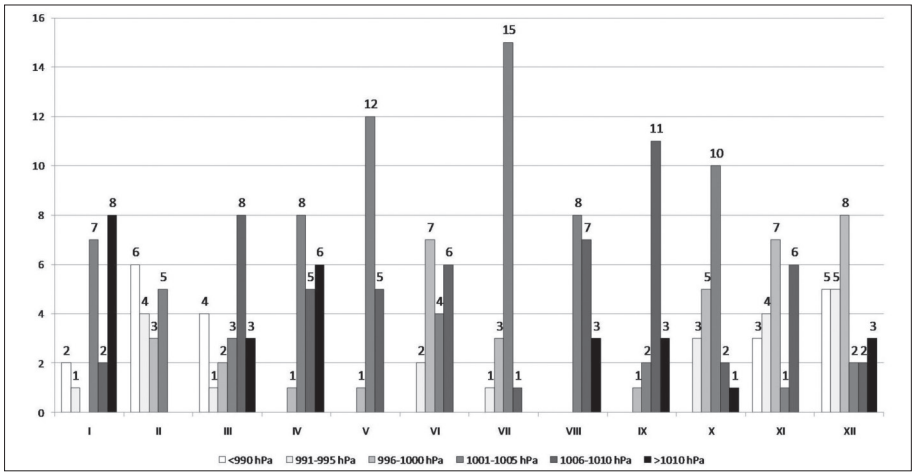

Fig 3. Monthly distribution of air pressure during semen collection (number of days in each month when semen was collected at a specific pressure)

Şekil 3. Semen toplanması boyunca hava basıncının aylara göre dağılımı (belli bir hava basıncında semen toplandığında her aydaki günlerin sayısı)

in the concentration of sperm in the ejaculate. The data in *Table 3* show there is a dependence of sperm motility on atmospheric pressure at ejaculation. As the atmospheric pressure increased, motility in the ejaculates increased too. The highest level of sperm motility was found in ejaculates collected at atmospheric pressure above 1010 hPa. Motile sperm rate exceeded 72% and was higher by 0.99% than in ejaculates collected at 991-995 hPa (P<0.01) and by 2.04% higher than in those collected at atmospheric pressure not exceeding 990 hPa (P<0.01).

Sperm count was highest in ejaculates collected at the lowest atmospheric pressure range, not more than 990 hPa. *(Fig. 3)* It exceeded 64 billion (10^9) and was higher by more than 4.1 billion than in ejaculates collected at 996-1000 hPa (P<0.05). The greatest number of insemination doses per ejaculate, exceeding 25, was found in low atmospheric pressures not exceeding 990 hPa (Group I) and at high pressures above 1010 hPa (Group VI). The average number of insemination doses obtained from ejaculates qualified for the Groups II, III, IV and V was lower by more than 1.5 insemination doses (P<0.05).

DISCUSSION

The resulting data suggest that the characteristics of ejaculates depend on the piggery microclimate parameters present during semen collection. The highest sperm concentration was found in ejaculates collected at low air temperatures, below 10°C. Moreover, ejaculates collected at lower temperatures had a good volume. It seems that boars do not have a particular susceptibility to low air temperatures during ejaculation. Low temperatures then have no negative effects on ejaculation performance of boars. Ejaculates collected at higher temperatures had a significantly lower sperm concentration. Spermatogenesis runs best in air temperature ranging from 15 to 20°C in bulls [17]. Most ejaculates in this study were collected within this thermal range (groups II and III). Air temperature at ejaculation is not, however, the only factor that may affect the ejaculate traits. Air temperature during the entire period of spermatogenesis is also vital, and this period may begin as early as 70 days before ejaculation [18].

Motility and morphology of sperm are sensitive indicators of heat stress [19]. The extent of morphological changes in spermatozoa depends on the duration of heat impact and on the adaptability of males to the conditions of heat stress [20]. Adaptation is less easy with higher diurnal temperature variations [21]. Heat stress directly affects reproductive performance of boars, but also has an indirect impact, by provoking changes in the energy balance [22]. Wettemann et al.[23] observed that increased temperature of the air is accompanied by a reduced quality of porcine semen without distinct changes in the ejaculate volume or libido. Increased thermal conditions resulted in sperm concentration reduced by 50% and in decreased average sperm motility, from 79.5% to 46.4% between the 3rd and 6th week of observations [23]. Stone [24], on the other hand, observed that sperm motility - as a result of temperature increase from 20°C to 40°C - dropped from about 93% to 19% after 3 weeks of such treatment. Our results reveal that sperm motility increases with an increase in temperature at ejaculation. Semen was collected at temperatures rather remaining within the thermal comfort zone for swine. In this study, the temperature never exceeded 29°C, at which - according to Sonderman and Luebbe [25] - spermatogenesis undergoes serious disturbances. Our study revealed that the highest proportion of progressively motile sperm was in ejaculates collected within the range 16-20°C and above 20°C (respectively 72.77% and 72.75%).

Season may affect the air temperature during the collection of ejaculates, which is particularly important in a temperate climate zone [2]. Therefore, in this study we recorded the number of days per each month when ejaculates were collected at a specific temperature *(Fig. 1)*.

The data presented in *Table 1* show that the best semen traits (ejaculate volume, motility, total sperm count) were found in semen collected at temperatures above 16°C. These ejaculates allowed preparation of the most AI doses. Monthly temperature distribution depicted in *Fig. 1* shows that the most days of semen collection at such temperatures are located between May and September. The period from May to September is not a good time in swine reproduction cycle [26]. At this time, boars generally produce ejaculates of lower quality. In summer the sexual activity of boars is often less intensive, which manifests in smaller ejaculate volumes and lower sperm counts, as reflected in the number of insemination doses made. Lower sperm counts in ejaculates collected in the summer months, as compared with the rest of the year, were found in the studies by Flowers [27]. During this period also more morphologically abnormal sperm are found [28]. The data of the presented study indicate, however, that this might not always be the case.

Air temperature in swine farming facilities strongly depend on the year season, which is depicted in *Fig. 1*. The most days of semen collection in which temperature did not exceed 10°C were from December to February. Ejaculates collected at 10°C and lower had the highest sperm concentrations. These results in conformity with data published by Ciereszko et al.[9] and Trudeau and Sanford [29], who analyzed ejaculates in relation to the season of semen collection. According to Knecht et al.[6], a high sperm concentration in ejaculates collected in winter results from lower temperatures, which has a positive effect on spermatogenesis. Auvigne [30] believes that this effect is due to the close kinship between the modern breeds of pigs and the European wild boar, for which the period of breeding activity is in late autumn and early winter, a period of a shortening length of daylight. This was confirmed by Knecht et al.[31], who obtained ejaculates of larger volume and with higher motility sperm from boars of various breeds during the period July - December, which was reflected in more insemination doses obtained from one ejaculate.

The results obtained in this study indicate that air relative humidity during the collection of ejaculates varied and depended largely on the season *(Fig. 2)*.

Air relative humidity in the piggery was 56-60% over most of the days of semen collection during autumn and winter (September - January). Ejaculates collected during this period were characterized by a large volume (250.17 ml on average) and a very low sperm concentration ($367.73 \times 10^3/mm^3$). On the other hand, ejaculates collected at a relative humidity of 50% and lower had the smallest volume (230.90 ml) and the highest sperm concentration ($412.91 \times 10^3/mm^3$). Such an air humidity level was most frequent from February to April *(Fig. 2)*, when ejaculates also had the highest sperm count (65.22 billion), enabling preparation of the highest number of doses (25.06 per ejaculate). With an increase in air humidity in the piggery, a higher rate of sperm showing progressive motility was observed too. Ejaculates collected at humidity lower or equal 60% demonstrated a lower percentage of progressively motile sperm as compared with the semen collected at an air humidity above 66%.

Relative air humidity is closely related to air temperature. There is the view that a combined effect of high temperature and high humidity is more detrimental to the functioning of testes than the effects of these two factors acting separately [32]. McNitt and First [33] found that placing boars for 72 h in a climatic chamber at 33°C and a relative humidity of 50% resulted in a decrease in the total spermatozoa count in the ejaculate and an increase in the percentage of spermatozoa with morphological abnormalities within about two weeks of the treatment. Similar conclusions were reached by Larsson and Einarsson [34], who placed boars for 100 h at 35°C and a relative humidity of 40%. The results were reduced ejaculate volume and a higher percentage of abnormal spermatozoa; total sperm counts in the ejaculates, however, remained unchanged. Suriyasomboon et al.[35] demonstrate that temperature and relative humidity have a significant effect on the volume of

ejaculate, and the total sperm count in ejaculates obtained from boars managed in various systems in Thailand. The authors found that a temperature increase in facilities for boars above 29°C at a relative humidity higher than 70% may have a negative effect on spermatogenesis. The number of articles on the impact of humidity on ejaculation performance is low and their results do not lead to clear conclusions. The data in this study prove that humidity is important for the quality of boar ejaculates and that in practice there are large fluctuations in air humidity during the collection of ejaculates. Therefore, there is a need for research and analysis of the impact of relative humidity on the basic quantitative and qualitative characteristics of ejaculate.

The impact of atmospheric pressure during the collection of ejaculates on their physical characteristics proved to be minor [36]. The highest sperm concentrations were obtained at an atmospheric pressure of 990 hPa and lower. Ejaculates collected at the lowest atmospheric pressure were found to have the lowest sperm motility. Differences between the other groups were insignificant and were not confirmed statistically. Atmospheric pressure is also partly related to the season of the year. Monthly distribution of atmospheric pressure at the time of collecting ejaculates is shown in *Fig. 3*.

The data presented in *Fig. 3* demonstrate that during spring and summer (April - August), air pressure in the piggery during semen collection was usually 1001-1005 hPa, and in autumn (November, December) 996-1000 hPa. Winter was characteristics for its highly varied pressure distribution in each month of the season. The data presented in this study, however, are hard to compare with other studies, since reports on these are lacking.

In conclusion, the studied microclimate parameters in the place of ejaculate collection may affect the quality of ejaculates. This effect, however, is varied. Each of the tested microclimate factors (temperature, humidity and atmospheric pressure) affects the characteristics of collected ejaculates differently and to a varying degree. Air temperature and atmospheric pressure at the time of semen collection affect the volume of the ejaculate and concentration of sperm in the semen. Ejaculates with the highest sperm concentration are obtained at extremely low temperatures (10°C or less), and at extremely low relative humidity. Sperm motility exhibits a distinct and oriented dependence in relation to air temperature, relative humidity of the air and atmospheric pressure. In ejaculates collected at the lowest air temperature, relative humidity of the air and atmospheric pressure were found least sperm with progressive motility. The highest numbers of sperm are found in ejaculates obtained at extremely low relative humidity (50% and lower) and at extremely low atmospheric pressure (not exceeding 900 hPa). Ejaculates collected in these conditions yielded the highest number of artificial insemination doses. Air temperature during semen collection has little influence on the total number of sperm per ejaculate and the number of artificial insemination doses obtainable from a single ejaculate.

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