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COMPARATIVE STUDY ON THE BIOLOGICAL FACTORS OF INFLUENCE ON THE SPERM QUALITY IN DIFFERENT BREED ROOSTERS

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Abstract

In this experiment, the influences of the breed, age, light intensity, and foot disorders on Cornish, Sussex and Plymouth Rock rooster sperm properties were monitored. The ejaculate volume, sperm density, motility and anomalies, dead spermatozoa, as well as the fecundity (calculated as hatching rate of the eggs provided by the hens inseminated by these roosters) were analyzed. Research has revealed different effects according to breed, age and light intensity on the volume of ejaculate, sperm density and motility. Ejaculate volume was higher in Cornish while density, motility, sperm anomalies and fecundity were higher in Sussex and Plymouth Rock. Age decreased significantly the ejaculated volume, and increased sperm anomalies and dead sperm percentages but didn't modify density and motility percentages of Cornish roosters. The intensity of light improved the biological characteristics of the sperm: ejaculated volume, density and fecundity increased significantly in Cornish but not in Sussex and Plymouth Rock. In Cornish roosters, the frequency of leg disorders diminished the ejaculated volume, sperm density and egg fecundity and increased the percent of the sperm anomalies and dead sperm.

***Key words**: sperm properties, fecundity, breeds, age, light, roosters.*

INTRODUCTION

According to Khaki et al. (2009), Lee et al. (2012) and Barkhordari et al. (2013) one of the major issues on breeding in farm animals is infertility, and approximately 30% of the problems are related to the males (Okoro et al., 2016). The specialized literature presents a broad approach to the main factors influencing the quality of the semen in birds, which are: 1. specific factors: genetic factors (breed, line), male traits (waist, age, health); 2. non-specific factors: the composition and quality of the food, and technology of exploitation. If the appraisals extend to fecundity (and even to hatchability), then to the factors above it can add other factors such as those related to incubation technology as well as those related to the physiological conditions of the inseminated females. Roosters with high semen producing capacity are often few and they degenerate due to changes in factors such as age, poor nutrition, unfavourable climatic conditions, and poor management (Okoro et al., 2016). The specialized literature presents a broad approach to the field, and, although in principle, things are known, the specialized publications are still supported by numerous works in that field. It is therefore very important to know the proportion of abnormal spermatozoa in a semen sample in order to determine the best semen characteristics for optimum fertility (Alkan et al., 2002). Our study focused on the effects of breed, age, light intensity and health status on the main characteristics of sperm in roosters.

MATERIALS AND METHODS

Research has been carried on three rooster breed: White Chornish, Sussex and Plymouth Rock, 30, 42 and 57 weeks aged, raised in the industrial system. The animals benefited from a program of 14.5 hours light from 5:30 to 20:00. The sex ratio was 1/4.5 in Cornish roosters, 1/5.5 in Sussex roosters and 1/6 in Plymouth Rock roosters. Cornish roosters were fed on 220 g of forage per capita and per day while

Sussex and Plymouth Rock chickens were fed *ad libitum*. Sperm sampling was performed according to the method described by Bunaciu et al. (1979). The semen was collected between 9:00 and 10:30. The ejaculate samples were collected in glass tubes which were kept at 37°C in suitable containers until sperm analysis. The volume of the ejaculate was measured using graduated glass micropipettes with a volume of 1.0 mL.

Sperm motility was determined by manual method. Viability smears were prepared on glass slides using 1% Eosin-Y and 10% Nigrosin and air dried. For each sample, at least 200 intact sperm cells were evaluated for percentage vitality estimation. Sperm density was determined after fixing the samples with 95% ethyl alcohol solution and counting sperm using a Türk count chamber and a Potain pipette for sample dilution. The percentage of sperm with abnormalities was manually determined by examination of the Eosin Nigrosin stained smears. To determine the effect of foot disorders (pododermartitis), characteristic of the Cornish breed, Cornish males who were diagnosed with such pathologies were used to obtain sperm samples.

Fertility was determined on the basis of the results obtained by incubation in the industrial system. In this sense, the percentage of eggs fertilized at the first mirage (after 6 days of incubation) was determined for each breed. The data were statistically analysed by ANOVA using a general linear model procedure of SAS (2002). The calculated descriptive statistics were mean and standard error of mean (SEM). Statistic comparison was performed between the experimentally different breed groups, and between the health and the affected Cornish group (with pododermatitis). The significance level for null hypothesis rejection was stated at $P < 0.05$.

RESULTS AND DISCUSSIONS

Table 1 presents the main characteristics of sperm as well as the fertility of 30-week-old rooster breeds: white Cornish, Sussex and Plymouth Rock. At this age, the differences between breeds are partly no significant statistically (for sperm density and percentage of dead sperm), but significant for ejaculate volume (higher in the Cornish breed, $P < 0.002$), sperm motility (higher in the Rock roosters, $P < 0.011$), the percentage of abnormal sperm (higher in Cornish, $P < 0.031$) and fertility (higher in Sussex and Rock, $P < 0.030$). The volume of the ejaculate correlates on the other hand with the size of the breed, the Cornish breed being from this point of view with the highest size. Higher rates of fertility in the Sussex and Plymouth Rock breeds may be correlated with sperm density, higher in these breeds than in Cornish, and also with sperm motility.

Studies on the properties of sperm in different rooster breeds (Cornish, Sussex, Minirock, Leghorn) were also performed by Bunaciu et al. (1978) and Bunaciu et al. (1979). Bunaciu et al. (1978) found a correlation between the percentage of abnormal sperm and motility, which shows that if the percentage of abnormal sperm is higher, the motility is lower.

Table 1. Morphological sperm properties and fecundty in Cornish, Sussex and Plymouth Rock rooster breeds, 30 week aged

Breed	Ejaculate volume (mL)	Sperm density ($x10^6$/mL)	Sperm motility (%)	Sperm anomalies (%)	Dead sperm (%)	Fecundity (%)
Cornish	0.19± 0.04	2.16 ± 0.10	88.7 ± 2.2	2.59 ± 0.20	0.64 ± 0.09	79.9 ± 7.7
Sussex	0.17 ± 0.02	2.82 ± 0.21	92.5 ± 5.5	2.83 ± 0.21	0.48 ± 0.10	84.0 ± 9.1
Plymouth Rock	0.12 ± 0.01	2.88 ± 0.22	92.2 ± 9.3	3.26 ± 0.12	0.61 ± 0.21	83.3 ± 3.2
P value	0.002	0.06	0.011	0.031	0.18	0.030

Note: data were calculated as mean ± standard error of mean

P values were calculated based on HSD (*honest significant difference)* Tukey test. Differences were considered significants for P<0.05. Fecundity was calculated as number of embryonic eggs and number of incubated eggs ratio

Evolution of Cornish rooster sperm properties according to age is presented in Table 2. According to the data from Table 2, ejaculate volume, sperm density, sperm anomalies and dead sperm percentages decreased significantly ($P < 0.05$) form 30 to 57 week of age. Fecundity percentage decreased significantly also ($P = 0.004$). The fact guides for the reformation of these roosters before or at the age of 57 weeks. Sperm motility percentage and sperm anomalies percentage remained unchanged statistically ($P = 0.19$ and $P = 0.09$, respectively), which would plead for the possibility of extending the exploitation of these breeds in industrial conditions at least up to the age of 57 weeks of life. Decreasing by about 10 percent the fertility of this breed from 30 to 57 weeks can ultimately orient the breeder's interests. Calculated phenotypic correlation between sperm motility on the one hand and the occurrence of defective sperm cells on the other was found negative by Jarinkovičová et al. (2012), as well as the correlation between sperm motility and sperm numbers, and between sperm motility and ejaculate volume. Changes in sperm properties in Cornish roosters have been described in connection with the season by Elagib et al. (2012): summer season caused a significant drop in semen volume in one year old and sperm concentration in two years old roosters. Summer also caused an increase in percent of dead sperm.

Effects of light intensity on the sperm features in different breed roosters are presented in Table 3.

Table 2. Sperm morphology and fecundity in Cornish roosters according to age

Age (weeks)	Ejaculate volume (mL)	Sperm density ($x10^6$/mL)	Sperm motility (%)	Sperm anomalies (%)	Dead sperm (%)	Fecundity (%)
30	0.19± 0.02	2.42 ± 0.11	89.2 ± 6.6	2.32 ± 0.04	0.87 ± 0.09	79.9 ± 6.0
42	0.21 ± 0.02	3.16 ± 0.06	88.72 ± 6.5	2.22 ± 0.04	1.11 ± 0.05	74.4 ± 5.4
57	0.15 ± 0.00	2.68 ± 0.06	91.3 ± 5.6	3.76 ± 0.03	1.91 ± 0.00	70.0 ± 5.5
P value	0.002	0.02	0.19	0.09	0.01	0.004

Note: data were calculated as mean ± standard error of mean

P values were calculated based on HSD (*honest significant difference)* Tukey test. Differences were considered significants for $P<0.05$. Fecundity was calculated as number of embryonic eggs and number of incubated eggs ratio

Table 3. Effect of light iensity on the sperm features in different breed roosters

Ligh intensity (W/m^2)	Ejaculate volume (mL)			Sperm density ($x10^6$/mL)			Fecundity (%)		
	Cornish	Sussex	Plymouth Rock	Cornish	Sussex	Plymouth Rock	Cornish	Sussex	Plymouth Rock
2.2	0.190	0.178	0.173	2.56	2.76	2.65	78.8	84.2k	84.5
6.3	0.231	0.188	0.193	2.54	2.78	2.65	80.3	86.6	86.0
8.4	0.230	0.182	0.184	2.64	2.90	2.78	86.9	87.6	88.9
P value	0.020	0.061	0.052	0.020	0.043	0.034	0.001	0.010	0.06

P values were calculated based on HSD (*honest significant difference)* Tukey test. Differences were considered significants for $P<0.05$. Fecundity was calculated as number of embryonic eggs and number of incubated eggs ratio

The increase of the light intensity caused the volume of the ejaculate to increase in all the three rooster breeds under observation. However, these increases were significant only in the Cornish breed ($P = 0.020$), being encoded at a difference of 0.04 mL, representing a percentage of 21.05%. But sperm density increased significantly in the entire three rooster breeds. These increasing were of 0.11 x 10^6/mL in Cornish, 0.14 x 10^6/mL in Sussex and 0.13 x 10^6/mL in Rock roosters. Improvement of these traits of sperm morphology was positively reflected in fertility rates, which increased significantly in all three rooster breeds. According to Dzoma (2010), fertility may be influenced by rooster and/or hen factors. Rooster fertility is influenced by age, stage of the breeding season, frequency of ejaculation, sperm supply, disease and nutrition. Hen fertility is influenced by reproductive age, feed energy levels, disease and efficiency in sperm storage. The vitamin content of the food, as well as the structure of the diet are factors that influence the quality of the sperm in the roosters (Danikowski et al., 2002).

Analysis of foot disorders in Cornish roosters led to the identification of up to 17% roosters with pododermatitis caused by contact with acid litter. These conditions

were accompanied by a weight loss below the average of healthy roosters by 24.5%. The morphological analysis of the sperm of these roosters led to the identification of a significant decrease of the ejaculate volume up to 22%, a decrease of the spermatogenesis reflected in the decrease of sperm density and an increase of sperm anomalies and dead sperm percent. The fecundity decreased up to 31% compared with health roosters of the same age. Bunaciu *et al.* (1987) conducted extensive studies on the effects of foot conditions on sperm quality in roosters. The authors drew attention to the economic importance of their treatment or prevention in the industrial raising complexes.

CONCLUSIONS

The morphological and functional characteristics of sperm in roosters are under the influence of biological and environmental factors, including age, breed, light, and claw disorders. Foot disorders can cause a significant decrease in the morphological characteristics of the sperm in Cornish roosters and the increase of the light intensity can have positive effects on spermatogenesis and fecundity.

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