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Analysis of Genetic and Non-genetic Factors Affecting Semen Traits in Baldi Black and New Zealand White Rabbits

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Abstract

LIMITED DATA exists on the genetics of semen traits in Egyptian local buck breeds compared to standard rabbit breeds. Genetic analysis was conducted on 520 ejaculates from 84 bucks of two breeds, Black Baldi and New Zealand White Rabbits, aged 6 months. The study aimed to assess heritability, common litter effects, spearman rank, phenotypic correlations between traits, and investigate non-genetic factors' influence. Most heritability for semen traits ranged from moderate (0.17 to 0.32), with the exception of sperm abnormality (Abno) and dead spermatozoa (dead). Moderate and high permanent environmental impacts ranged from 0.24 to 0.73. Spearman rank correlation between semen parameters was found to be positive, highly significant, and strong for whole ejaculate volume (WV) and net ejaculate volume (NV); WV and gel; WV and sperm concentration/ejaculate (Con/ej); NV and gel; and Con/ej (82 to 98). Phenotypic correlations were notably high and significantly strong between NV & WV, gel & WV, gel & NV, Con/ej & WV, Con/ej & NV, and Con/ej & sperm concentration (Con) (0.61 to 0.97). NZW bucks excel in WV, NV, gel, progressive sperm motility (PM), mass sperm motility (MM), Con, Con/ej, dead, and Libido score (Lib). Except for the pH value, all assessed characteristics showed notable variances between weeks. The birth parity significantly affected most analyzed semen traits. In autumn, the lowest mortality value was observed, while the highest values were recorded for WV, NV, gel, MM, Con, Con/ej, Liv, and Lib. Summer showed the lowest values for most semen characteristics.

Keywords: Heritability, Spearman rank and Phenotypic Correlations**,** Breed, Week, Parity and Season.

Introduction

Rabbits are widely distributed worldwide and contribute as a meat source in different countries. Semen characteristics are highly important since many females' fertility and reproductive abilities are controlled by males, particularly in artificial insemination (AI) farming systems [1]. AI effectiveness is based on its characteristics. For instance, libido can directly affect conception and kindling rates, and consequently, bucks must be checked for libido behavior. The concentration of sperm cells represents the main factor that indirectly determines the quality of semen [2]. Also, sperm motility plays a key characteristic for semen quality. According to [3], different breeds of rabbit bucks exhibit variations in reaction time, semen pH, semen density, semen color, mass motility, and advanced motility. These differences in sperm motility among breeds are associated with variations in the activity of the pituitary gland. Many trials were conducted to evaluate non-genetic factors of semen traits, while the genetic parameters of semen quality between Baladi and New Zealand breeds are not well characterized. This study aims to estimate the genetic differences in semen characteristics and the phenotypic correlations among these traits. Additionally, it examines the impact of non-genetic factors, including breed, week, parity, and season, on NZW and BB rabbits.

Material and Methods

A total of 520 ejaculates were collected from 84 bucks from two breeds of rabbits, New Zealand White (NZW) and Baladi Black (BB), at 6 months of age with an average weight of 3 to 3.5 kg. Ejaculates were collected from each buck, and semen traits were recorded over a five-week period. This experiment was conducted over four seasons at Sakha Animal Farm in Egypt, part of the Animal Production Research Institute, Agricultural Research Center, located in Kafrelshiekh Governorate, Egypt. The experiment adhered to the approved ethical

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guidelines of the Animal Production Research Institute (APRI), Agricultural Research Center. The experimental study plan was approved under reference number 1847020203429.

Management

All bucks in this study were housed in individual cages and fed ad libitum with a commercial pelleted ration containing 16.3% crude protein, 13.2% crude fiber, 2.5% ether extract, 0.6% mineral mixture, and providing 2600 kcal/kg. During the winter and early spring months, berseem was supplied, and fresh, clean water was available at all times.

The average air temperature inside the rabbit building was 18.2 ^{o}C during winter, 23.6 ^{o}C during spring, 32.6 ^{o}C during summer, and 24.0 ^{o}C during autumn. The relative humidity percentage was 75.6% during winter, 65.0% during spring, 82.0% during summer, and 63.7% during autumn. The average light period is 14 to 16 hours throughout the four seasons.

Collection and evaluation of semen

Semen was collected from bucks using the artificial vaginas of rabbits. Immediately after ejaculation, the gel plug was promptly removed, and the semen was maintained at a temperature between 35 and 37 degrees Celsius in a water bath. Semen samples were collected at 8:00 a.m. and transported to the laboratory for analysis. Upon collection, the pH of the semen was measured using a pH meter pen. The total semen volume, excluding the gel fraction, was measured using a graduated collection test tube. Percentages of progressive motility, spermatozoa abnormalities, and viability were assessed in semen samples diluted. The percentage of sperm abnormalities was assessed when analyzing the ratio of live to dead sperm under high magnification (400x). Sperm concentration was measured using a Neubauer hemocytometer. Live sperm cells (unstained) were tallied within a sample of 200 sperm cells, and the live sperm percentage was computed. Bucks with diminished libido received a score of 1, while those displaying robust libido were scored 5, following the procedure outlined in reference [4].

Traits analyzed

The traits analyzed were WV = Whole ejaculate volume (mL); NV = Net ejaculate volume (mL);, Semen gel volume (mL) = gel, Semen pH value = pH, Mass sperm motility (%) = MM, Progressive sperm motility (%) = PM, Motile sperm (mL) = IS, Sperm concentration ($\times 10^6$/mL) = Con, Sperm concentration ($\times 10^6$/ejaculate) = Con/ej, Sperm abnormality (%) = Abno, Dead spermatozoa (%) = Dead, Sperm livability (%) = Liv and Libido score = Lib were recorded in the experiment.

Statistical analysis

Data were analyzed using the multi-trait animal model MTDFREML programs of [5] to obtain heritability (h^2), permanent environmental effects (p^2), and random error effects (e^2).

Based on the general model:

$$Y = X_b + Z_{1a} + Z_{2p} + e \qquad \text{[Model1]}$$

Here, Y represents the observation vector, X is the fixed effects incidence matrix; b is the vector of fixed effects, which includes breed (NZW and BB), week (1st, 2nd, 3rd, 4th, and 5th week), birth parity (1st, 2nd, and 3rd parity), and season (winter, spring, summer, and autumn); Z1 and Z2 are matrices representing the random effects of additive (a) and permanent environmental effects (p).

Weighted least squares, a method in SAS's GLM procedure, was utilized for data analysis in 2003. Least squares were then used to compare means via a multiple-range test for trait characteristics. Furthermore, Spearman rank correlations between predicted transmitting ability estimates for traits were calculated using the correlation procedure outlined by the program [7].

As per the general model:

$$Y_{ijkl} = \mu + B_i + W_j + P_k + S_l + e_{ijkl}. \qquad \text{[Model2].}$$

Here, Y_{ijkl} represents the parameters on the ijklth carcass characteristics, μ denotes the overall mean, B_i signifies the fixed effect of the ith breeds (i= NZW and BB); W_j indicates the fixed effect of the jth week indicates (j = 1st, 2nd, 3rd, 4th, and 5th of week); P_k represents the fixed effect of the kth parity of birth (k=1st, 2nd, and 3rd of parity); S_l shows the fixed effect of the lth season (l= winter, spring, summer, and autumn) and e_{ijkl} accounts for the random deviation of all the other effects not specified in the model.

Results

Means

Table 1 describes the semen performance of bucks from NZW and BB rabbits. Most were highly variable in CV% and ranged from 3.02 for sperm livability to 47.48% for sperm concentration or ejaculation.

Heritability and permanent environmental effects:

Most heritability was estimated for semen traits, with values that were moderate and ranged from 0.17 to 0.32, except for sperm abnormality, dead spermatozoa, and sperm livability, which ranged from 0.07 to 0.12, as depicted in Table 2.

Spearman rank and phenotypic correlations

The estimated spearman rank correlation among records of semen traits is depicted in Table 3. We observed a significant positive correlation among whole ejaculate volume and net ejaculate volume; whole ejaculate volume and gel; whole ejaculate volume and sperm concentration/ejaculate; net ejaculate volume and gel and sperm concentration/ejaculate. Also, we observed highly significant phenotypic correlations between net ejaculate volume & whole ejaculate volume; gel & whole ejaculate volume; gel & net ejaculate volume; sperm concentration/ ejaculate &whole ejaculate volume; sperm concentration/ ejaculate & net ejaculate volume sperm; and concentration/ ejaculate & sperm concentration.

Non-genetic factors:

Effect of breed

Table 4 shows that there were substantial differences across breeds in the majority of the variables studied. The NZW bucks had superior whole ejaculate volume, net ejaculate volume, semen gel volume, mass sperm motility, progressive sperm motility, sperm concentration, sperm concentration/ejaculate, dead spermatozoa, and Libido score, while the BB Bucks breed had superior motile sperm and sperm livability.

Effect of the week

Except for the semen pH value, the results in Table 5 reveal that the week had significantly affected most investigated traits.

Effect of parity of birth

The effects of parity of birth on semen traits are depicted in Table 6. The data indicated that progressive sperm motility, motile sperm, sperm abnormalities, and dead spermatozoa were higher in the first parity**.** Also, semen pH value and sperm livability were higher in the second parity. Also, mass sperm motility, sperm concentration/ejaculate, and libido score were higher in the third parity.

Effects of the season

Data on the impact of the season on semen quality is presented in Table 7. Season significantly influenced semen traits, except for semen pH value and mass sperm motility.

Discussion

The ranges for semen parameters were obtained within the range to those reported in [8, 9]. As well, [10] also showed that semen physical characteristics are highly variable, with the coefficient of variation (CV %) ranging from 3.04 for fresh ejaculate pH to 72.90 for reaction time. The greatest variability was found in the libido of bucks, sperm livability, and sperm count, whereas sperm motility appeared less variable. This variability may be due to the use of bucks of different ages and breeds, as well as the small sample size of bucks in the study.

The low to moderate estimated heritability of semen traits in our study can be attributed to the limited genetic variability within the population and significant maternal or permanent environmental effects, which obscure any additive genetic variance. Improving these traits may be possible through crossbreeding.

The permanent environmental effects on the same traits were moderate to high, ranging from 0.24 to 0.73, indicating the significant influence of maternal or permanent environmental factors. These findings align with those of [9], who reported moderate heritability values (0.12 to 0.18) and permanent environmental effects (0.15 to 0.28). In this connection, [11] indicated that genetic selection represents a difficult method to improve libido and mating behaviors in boars as phenotypic variation for such characters is low. According to [12], variables related to ejaculate quality exhibit low heritability values (h2 ranging from 0.04 to 0.11). These variables include the presence of urine and calcium carbonate deposits in the ejaculate, ejaculate pH, individual sperm motility, suitability of the ejaculate for artificial insemination (AI), and libido. These findings suggest that seminal quality in bucks at AI centers is more influenced by managerial practices than by genetic selection. On the other hand, sperm concentration, ejaculate volume, and sperm production per ejaculate have moderate heritability values. Furthermore, [13] reported that heritability estimates for semen traits ranged from 0.05 to 0.18. Specifically, pH, volume, and mass motility had lower estimates around 0.05–0.06, whereas concentration (0.10), total sperm count per ejaculate (0.12), and motility traits showed considerably higher heritability. Notably, the percentage of motile sperm exhibited the highest heritability at 0.18, suggesting it holds promise as a potential criterion for selecting both motility and sperm quantity.

The results of the Spearman rank correlation among semen trait records align closely with those reported by [14], indicating significant genetic correlations between concentration and volume. These findings underscore the importance of these traits in the assessment of ejaculate quality. [15], found strong positive associations between the net semen ejaculate and other semen parameters such as sperm concentration per ejaculate, initial motility percentage, and conception rate. Furthermore, [13] reported that the two components of total sperm ejaculate (TSE), volume and concentration, exhibited

a positive correlation (rg = 0.38). Semen pH showed positive correlations with volume and all indicators of high sperm motility, but not with concentration. Mass motility emerged as a strong candidate for semen quality selection due to its high genetic correlations with various other semen traits. Specifically, it was strongly correlated with concentration (rg = 0.68) and TSE (rg = 0.70).

Contrarily, [16] found that semen pH showed a negative correlation with sperm concentration, mass motility, and the percentage of motile spermatozoa. This inverse relationship between pH and other sperm characteristics can be attributed to the metabolic activity of spermatozoa, which predominantly utilize fructose for energy and produce lactic acid, thereby reducing pH levels. The author also reported a non-significant genetic correlation between semen concentration and volume in rabbit bucks, ranging from 0.38 to 0.45. Additionally, [12] demonstrated a significant negative genetic correlation between concentration and volume. According to [17], there is a notable negative relationship between reaction time and several sperm parameters, including net ejaculate volume, sperm concentration per ejaculate, and the percentage of non-viable sperm. The presence of coiled spermatozoa shows a positive correlation with various sperm output metrics, with the strongest associations observed with normal and live sperm counts, followed by functional, total, and motile sperm counts (correlation coefficients of 0.82, 0.81, and 0.81 respectively). Additionally, the occurrence of coiled sperm is linked to sperm expulsion characteristics, such as normal and viable sperm expulsion, followed by functional integrity and motility of the expelled sperm, in respective order.

Compared to the BB bucks breed, New Zealand White (NZW) bucks generally exhibited superior semen characteristics under Egyptian conditions. It is recommended to use NZW bucks for crossbreeding with females of the Black Baladi breed to enhance semen quality in this breed. These findings contrast with those of [18], who reported that BB bucks showed higher libido and physical semen traits, including semen volume per ejaculate excluding gel fractions, sperm concentration, total sperm count, sperm abnormalities, acrosomal damage, dead spermatozoa, and progressive sperm motility, compared to NZW bucks. Additionally, BB bucks had higher percentages of motile sperm, swollen spermatozoa, and coiled tail spermatozoa than NZW bucks.

Various studies have identified breed-specific variations. For instance, according to [19], the Californian breed showed lower reaction times and semen pH levels compared to the NZW breed. Additionally, the Californian breed exhibited larger ejaculate volumes, higher percentages of live sperm, and greater sperm production compared to NZW. Conversely, NZW bucks had higher pH levels compared to the Californian breed. According to [20], M-line bucks were found to have higher ejaculate volumes, sperm cell concentrations, individual motility, mass motility, live sperm counts per ejaculate, and sperm abnormalities per ejaculate compared to Gabali and V-line bucks. According to [15], the main characteristics studied in the Baldi Red breed showed lower values for response time, total ejaculate volume including the gel portion, and dead spermatozoa, while exhibiting higher values for net ejaculate volume excluding the gel portion, semen pH, and initial sperm motility ($p \leq 0.001$). According to [21], New Zealand White rabbits showed higher values in semen volume, motility, and libido compared to the New Zealand Red and Chinchilla breeds. The study also highlighted that rabbits in this investigation exhibited stronger genetic predispositions towards reproductive ability and fertility, as evidenced by increased semen volume and total sperm count.

On the contrary, according to [10], several reproductive characteristics were found to be unaffected by breed differences. These traits included reaction time, semen volume per ejaculate excluding gel fractions, sperm cell concentration, percentage of sperm abnormalities, percentage of dead spermatozoa, percentage of advanced sperm motility, mass motility grade, total sperm output, semen color grade, semen density grade, and semen pH across breeds such as Gabali, Rex, Californian, and New Zealand White rabbits.

The current study did not observe a consistent trend regarding the effect of the collection week. In contrast, [17] found that the collection week influenced sperm motility, with significant improvements noted after three weeks. Additionally, sperm livability and abnormality showed notable improvements after six weeks. Sperm cell concentration also exhibited a slight, gradual improvement as the collection weeks progressed. [22] found that prolonging the collection weeks significantly enhanced semen quality, including ejaculate volume, sperm concentration, and viability percentages, while also reducing the percentages of abnormal sperm.

Changes in birth parity are mainly linked to the dam's efficiency, as mothers exhibit a higher maternal ability to nourish their young until weaning [23].

The highest values for progressive sperm motility and motile sperm were observed in winter. In contrast, dead spermatozoa were at their lowest during autumn. Additionally, the autumn season saw

the highest values for whole ejaculate volume, net ejaculate volume, semen gel volume, mass sperm motility, sperm concentration, sperm concentration per ejaculate, sperm livability, and libido score.

The lowest values for semen characteristics were observed during the summer. Both ambient temperature and photoperiod length can affect semen properties [24]. Higher ambient temperatures lead to a decline in semen quality, as they reduce the ability of Leydig and Sertoli cells to respond to LH and decrease the size of the seminiferous tubules [25].

The results of this study are largely consistent with [18], who reported that many semen characteristics improved during winter compared to summer. Conversely, [20] found that semen pH reached its highest values during the summer in the M-line breed. Additionally, the V-line breed exhibited the highest ejaculate volume during autumn, while the M-line breed recorded the highest sperm cell concentration in spring. The M-line breed also achieved the highest individual motility values during autumn.

Conclusion

Crossbreeding could potentially enhance these traits, although the relatively low and moderate heritability estimates of semen traits in this study suggest limited genetic variability within the population. This could be influenced by significant maternal effects or other factors that might obscure any additive genetic variance.

NZW bucks showed superiority over most semen characters under Egyptian conditions compared with the BB Bucks breed. It is recommended to use New Zealand buck for crossing with females of the Black Baladi breed in order to improve the characteristics of the semen of this breed.

Progressive sperm motility, motile sperm, sperm abnormalities, and dead spermatozoa were higher in the first parity**.** Also, semen pH value and sperm livability were higher in the second parity. Also, mass sperm motility, sperm concentration/ejaculate, and libido score were higher in the third parity. These changes with parity of birth are primarily related to the dam's efficiency, as a mother had a higher maternal ability to feed her young until weaning.

Winter had the highest progressive sperm motility and motile sperm values, while spring had the highest semen pH value and sperm livability, and the lowest semen characteristics were observed in summer. It is recommended to use a selection of bucks during the winter and spring. Bucks are not used for insemination during the summer due to the lack of quality semen.

Ethical approval: The experiment was conducted in compliance with the Ethics committee for using animals of Agricultural Research Center, Animal Production Research Institute (APRI) approved the experimental study plan with the number (1847020203429).

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TABLE 1. **Semen traits of NZW and BB rabbits, means, and coefficients of variation (CV%)**

Item	**Description**				
raits	**Means**	**S.D**	**CV%**	**Min.**	**Max.**
Whole ejaculate volume (mL)	1.11	0.43	38.78	0.30	2.10
Net ejaculate volume (mL)	0.76	0.30	39.51	0.20	1.60
Semen gel volume (mL)	0.35	0.16	44.07	0.10	0.80
Semen pH value	7.82	3.54	45.18	6.50	8.00
Mass sperm motility (%)	61.27	14.11	23.02	30.0	85.0
Progressive sperm motility (%)	71.58	11.89	16.62	30.0	90.0
Motile sperm (mL)	19.58	5.52	28.18	10.0	35.0
Sperm concentration ($\times 10^6$/mL)	385.60	86.36	22.40	200	540
Sperm concentration ($\times 10^6$/ejaculate)	293.79	139.48	47.48	100	676
Sperm abnormality (%)	8.92	3.49	39.21	2.0	18.0
Dead spermatozoa (%)	15.02	2.56	17.07	10.0	20.0
Sperm livability (%)	84.98	2.57	3.02	80.0	90.0
Libido score	3.32	0.76	22.87	1	4

TABLE 2. Estimates for heritability (h^2), the permanent environmental effect (p^2), and random error effects (e^2) with standard errors (±SE) for semen traits of NZW and BB rabbits

Item	Effect		
Traits	**h^2±SE**	**^{p2}±SE**	**e^2±SE**
Whole ejaculate volume (mL)	0.17 ± 0.19	0.61 ± 0.05	0.23 ± 0.22
Net ejaculate volume (mL)	0.32 ± 0.19	0.24 ± 0.02	0.44 ± 0.20
Semen gel volume (mL)	0.22 ± 0.20	0.66 ± 0.04	0.12 ± 0.21
Semen pH value	0.21 ± 0.19	0.29 ± 0.21	0.49 ± 0.03
Mass sperm motility (%)	0.28 ± 0.20	0.60 ± 0.20	0.12 ± 0.02
Progressive sperm motility (%)	0.23 ± 0.21	0.52 ± 0.04	0.25 ± 0.22
Motile sperm (mL)	0.17 ± 0.22	0.56 ± 0.22	0.26 ± 0.02
Sperm concentration ($\times10^6$/mL)	0.23 ± 0.18	0.60 ± 0.16	0.17 ± 0.03
Sperm concentration ($\times10^6$/ejaculate)	0.20 ± 0.01	0.62 ± 0.03	0.18 ± 0.01
Sperm abnormality (%)	0.07 ± 0.21	0.73 ± 0.05	0.19 ± 0.22
Dead spermatozoa (%)	0.08 ± 0.21	0.55 ± 0.21	0.37 ± 0.03
Sperm livability (%)	0.12 ± 0.19	0.33 ± 0.02	0.55 ± 0.19
Libido score	0.24 ± 0.03	0.46 ± 0.03	0.30 ± 0.02

TABLE 3. Spearman rank correlations among the breeding values (above diagonal) and phenotypic correlations (below diagonal) for semen traits of NZW and BB rabbits

Trait	WV	NV	Gel	pH	MM	PM	IS	Con	Con/ej	Abno	Dead	Liv	Lib
WV	1	0.98***	0.91***	0.05	0.02	-0.03	-0.04	0.26***	0.99***	-0.15***	-0.03	0.05	-0.18***
NV		1	0.82***	0.05	0.03	-0.03	-0.05	0.25***	0.10***	-0.15**	-0.05	0.06	-0.16***
Gel			1	0.03	-0.15	-0.04	-0.01	0.23***	0.91***	-0.13**	0.04	0.01	-0.17***
pH				1	0.08	0.07	-0.11*	0.01	0.05	-0.10*	-0.16**	0.22***	-0.09
MM					1	0.08	-0.06	-0.05	0.02	0.06	-0.04	0.10*	0.02
PM						1	-0.30***	0.08	-0.03	-0.10*	-0.01	-0.01	-0.08
IS							1	-0.11*	-0.04	0.02***	0.12**	-0.13**	0.12**
Con								1	0.26***	-0.87	-0.07	0.10*	-0.10*
Con/ej									1	-0.15**	-0.03	0.05	-0.18***
Abno										1	-0.08	-0.06	0.02
Dead											1	-0.82***	0.04
Liv												1	-0.07
Lib													1

WV = Whole ejaculate volume (mL); NV = Net ejaculate volume (mL); Semen gel volume (mL) = gel, Semen pH value = pH, Mass sperm motility (%) = MM, Progressive sperm motility (%) = PM, Motile sperm (mL) = IS, Sperm concentration ($\times10^6$/mL) = Con, Sperm concentration ($\times10^6$/ejaculate) = Con/ej, Sperm abnormality (%) = Abno, Dead spermatozoa (%) = Dead, Sperm livability (%) = Liv and Libido score = Lib.

TABLE 4. The least squares means and standard errors for semen traits affected by breed

Item	Breed		*p*-value
Traits	**NZW**	**BB**	
WV	1.19±0.03[a]	1.03±0.03[b]	0.0001
NV	0.82±0.02[a]	0.69±0.02[b]	0.0001
Gel	0.37±0.01[a]	0.33±0.01[b]	0.006
pH	7.52±0.23	8.17±0.25	<0.05
MM	65.78±0.89[a]	56.20±0.95 [b]	0.0001
PM	72.37±0.77	70.69±0.82	0.135
IS	19.32±0.34	19.87±0.36	0.269
Con	393.05±5.9	380.97±6.26	0.161
Con/ej	320.63±9.4[a]	263.61±9.9[b]	0.0001
Abno	8.32±0.23[a]	9.61±0.24[b]	0.0001
Dead	15.15±0.16	14.87±0.17	0.236
Liv	84.85±0.16	85.13±0.17	0.243
Lib	3.33±0.05	3.32±0.05	0.848

Means with different superscript letters in the same row are significantly different (p<0.05). WV = Whole ejaculate volume (mL); NV = Net ejaculate volume (mL);, Semen gel volume (mL) = gel, Semen pH value = pH, Mass sperm motility (%) = MM, Progressive sperm motility (%) = PM, Motile sperm (mL) = IS, Sperm concentration ($\times10^6$/mL) = Con, Sperm concentration ($\times10^6$/ejaculate) = Con/ej, Sperm abnormality (%) = Abno, Dead spermatozoa (%) = Dead, Sperm livability (%) = Liv and Libido score = Lib.

TABLE 5. The least squares means and standard errors for semen traits affected by the week of NZW and BB rabbits

Item	Week					*p*-value
Traits	1st	2nd	3rd	4th	5th	
WV	1.12±0.05^{ab}	1.18±0.05^{ab}	0.97±0.05^{c}	1.06±0.05^{bc}	1.21±0.05^{a}	0.002
NV	0.77±0.03^{abc}	0.97±0.03^{ab}	0.68±0.03 ^{c}	0.72±0.03^{bc}	0.82±0.03^{a}	0.012
gel	0.35±0.02^{a}	0.39±0.02^{a}	0.30±0.02^{ab}	0.34±0.02^{ab}	0.38±0.02^{a}	0.0007
pH	7.67±0.38	7.71±0.38	7.69±0.38	8.50±0.38	7.64±0.38	0.449
MM	59.84±1.44^{b}	60.01±1.44^{b}	59.66±1.44^{b}	60.48±1.44^{b}	64.95±1.44^{a}	0.05
PM	69.89±1.25^{b}	73.82±1.25^{a}	71.88±1.25^{ab}	70.55±1.25^{ab}	71.50±1.25^{ab}	0.05
IS	20.59±0.56^{a}	19.09 ±0.56^{ab}	18.49±0.56^{b}	20.31±0.56^{a}	19.49±0.56^{ab}	0.05
Con	370.1±9.21^{b}	348.7±9.21^{b}	396.0±9.21^{a}	407.5±9.21^{a}	412.7±9.21^{a}	0.0001
Con/ej	278.6±14.9^{b}	273.2±14.9^{b}	271.5±14.9^{b}	291.8±14.9^{b}	345.6±14.9^{a}	0.002
Abno	9.63±0.37^{a}	9.0.3±0.37^{ab}	9.08±0.37^{ab}	8.78±0.37^{ab}	8.28±0.37 ^{b}	0.015
Dead	15.23±0.26^{a}	14.84±0.26^{ab}	15.09±026^{ab}	15.54±0.26^{a}	14.36±0.26 ^{b}	0.035
Liv	84.76±0.26^{b}	85.16±0.26^{ab}	84.91±0.26^{ab}	84.46±0.26^{b}	85.64±0.26 ^{a}	0.034
Lib	3.39±0.08^{b}	3.08±0.08^{c}	3.18±0.08^{bc}	3.35±0.08^{b}	3.61±0.08 ^{a}	0.001

Means with different superscript letters in the same row are significantly different (p<0.05). WV = Whole ejaculate volume (mL); NV = Net ejaculate volume (mL);, Semen gel volume (mL) = gel, Semen pH value = pH, Mass sperm motility (%) = MM, Progressive sperm motility (%) = PM, Motile sperm (mL) = IS, Sperm concentration ($\times10^6$/mL) = Con, Sperm concentration ($\times10^6$/ejaculate) = Con/ej, Sperm abnormality (%) = Abno, Dead spermatozoa (%) = Dead, Sperm livability (%) = Liv and Libido score = Lib.

TABLE 6. The least squares means and standard errors of semen traits effected by parity in NZW and BB rabbits

Item	Parity			*p*-value
Traits	1st	2nd	3rd	
WV	1.16±0.04^{a}	1.03±0.03^{b}	1.16±0.03^{a}	0.017
NV	0.78±0.03	0.72±0.02	0.78±0.02	0.087
Gel	0.37±0.01^{a}	0.32±0.01^{b}	0.37±0.01^{a}	0.001
pH	7.32±0.31^{b}	8.32±0.28^{a}	7.75 ±0.22^{ab}	0.05
MM	61.76±1.26	59.47±1.15	62.67±1.15	0.106
PM	76.45±1.03^{a}	70.10±0.94^{b}	69.00±0.94^{b}	0.0001
IS	22.73±0.46^{a}	18.14±0.42^{b}	18.39±0.42^{a}	0.0001
Con	388.92±7.96	380.93±7.27	392.51±7.27	0.51
Con/ej	301.40±12.42^{ab}	272.22±11.34^{b}	309.03±11.34^{a}	0.05
Abno	9.97±0.31^{a}	8.19±0.28^{b}	8.79±0.28^{b}	0.0001
Dead	15.97±0.22^{a}	14.60±0.20^{b}	14.65±0.20^{b}	0.0001
Liv	84.02±0.22^{b}	85.40±0.20^{a}	85.35±0.20^{a}	0.0001
Lib	3.21±0.07^{b}	3.30±0.06^{ab}	3.44±0.06^{a}	0.03

Means with different superscript letters in the same row are significantly different (p<0.05). WV = Whole ejaculate volume (mL); NV = Net ejaculate volume (mL); Semen gel volume (mL) = gel, Semen pH value = pH, Mass sperm motility (%) = MM, Progressive sperm motility (%) = PM, Motile sperm (mL) = IS, Sperm concentration ($\times10^6$/mL) = Con, Sperm concentration ($\times10^6$/ejaculate) = Con/ej, Sperm abnormality (%) = Abno, Dead spermatozoa (%) = Dead, Sperm livability (%) = Liv and Libido score = Lib.

TABLE 7. The least squares means and standard errors of semen traits affected by the season of NZW and BB rabbits

Item	Season				*p*-value
Traits	Winter	Spring	Summer	Autumn	
WV	1.15±0.04^{ab}	1.02±0.03^{c}	1.09±0.04^{c}	1.26±0.05^{a}	0.0001
NV	0.77±0.03^{ab}	0.71±0.02^{b}	0.73±0.03^{b}	0.84±0.04^{a}	0.010
Gel	0.36±0.02^{b}	0.31±0.01^{bc}	0.35±0.02^{bc}	0.41±0.02^{a}	0.0001
pH	7.30±0.32	8.30±0.29	7.79±0.39^{a}	7.69±0.47	0.159
MM	60.74±1.21	59.46±1.11	62.33±1.14	63.16±1.24	0.209
PM	75.44±0.99^{a}	70.00±0.91^{b}	71.11±1.17^{b}	65.83±1.14^{c}	0.0001
IS	21.81±0.46^{a}	17.94±0.42^{bc}	17.68±0.54^{c}	19.43±67^{b}	0.0001
Con	387.41±7.50^{b}	381.00±6.96^{b}	369.56±8.98^{b}	426.93±11.0^{a}	0.0006
Con/ej	300.00±11.37^{a}	271.22±10.36^{b}	270.80±13.40^{b}	366.37±16.4^{a}	<0.0001
Abno	10.00±0.29^{a}	8.14±0.27^{b}	9.31±0.35^{a}	8.00±0.43^{b}	<0.0001
Dead	16.0±0.22^{a}	14.6 ±0.20^{b}	14.50±0.24^{b}	15.4±0.54^{b}	<0.0001
Liv	84.40±0.21^{b}	85.60±0.19^{a}	85.52±0.25^{a}	84.6±0.54^{a}	<0.0001
Lib	3.10±0.06^{b}	3.20±0.06^{b}	3.38±0.07^{ab}	3.53±0.09^{a}	0.044

Means with different superscript letters in the same row are significantly different (p<0.05). WV = Whole ejaculate volume (mL); NV = Net ejaculate volume (mL); Semen gel volume (mL) = gel, Semen pH value = pH, Mass sperm motility (%) = MM, Progressive sperm motility (%) = PM, Motile sperm (mL) = IS, Sperm concentration ($\times10^6$/mL) = Con, Sperm concentration ($\times10^6$/ejaculate) = Con/ej, Sperm abnormality (%) = Abno, Dead spermatozoa (%) = Dead, Sperm livability (%) = Liv and Libido score = Lib.

References

1. Alvarino, J. M. R. Reproductive performance of male rabbits. *Proceedings of the Seventh World Rabbit Congress, Valencia, Spain,* Vol. **A**, pp. 13–35(2000)**.**
2. Hagen, D. R., Gilkey, A. L. and Foote, R. H. Spermatozoa velocity and motility and their relationship to fertility in rabbits inseminated with low sperm numbers *World Rabbit Sci.,* **10**(4), 135–140 (2002).
3. Abd El-Azim, A. and El-Kamash, E. M. Evaluation of semen quality and its relation to mating systems for some breeds of rabbits under environmental conditions in the middle of Egypt. *Poult. Sci.,* **31**, 467–480 (2011).
4. Amman, R. P. and Hammerstedt,R. H. Validation of a system for computerized measurements of spermatozoa velocity and percentage of motile sperm . *Biol. Reprod.,* **23**, 647–656(1980).
5. Boldman, K. G., Kriese, L. A., Van Tassell, C. P., and Kachman, S. D. (1995). A manual for the use of MTDFREML A set program to obtain estimates of variances and covariance [DRAFT] U.S. Department of Agriculture, Agricultural Research Service, and USA.
6. Duncan, D. B. Multiple ranges and multiple F-tests. *Biometrics,* **11**,1-42. (1955).
7. SAS Institute (2003). SAS/STAT user guide SAS Institute Inc., Cary, NC, USA.
8. Al-Sobayil, K. and Khalil, M. H., (2002). Semen characteristics of buck in a cross-breeding project involving Saudi Gabali with V-line rabbits in Saudi Arabia *3rd Sci. Conf. on Rabbit Prod. In Hot Climates,* 8–11 October, Hurghada, Egypt, pp. 151–163.
9. Khalil, M. H., Al-Sobayil, K. A., Al-Saef, A. M., Garcı, M. L. and Baselga, M. Genetic evaluation for semen characteristics in a crossbreeding project involving Saudi and Spanish V-line rabbits. *Animal,* **1**(7), 923–928(2007).
10. Anous, M. R., Abdalah, E. B. and Abdou A., El-Badawy, A. A. Semen quality characteristics and plasma seminal protein patterns of different Egyptian rabbit bucks. *Egyptian J. Anim. Prod.,* **54** (3), 215-222. (2017).
11. Flowers, W. L. Genetic and phenotypic variation in reproductive traits of AI boars. *Theriogenology,* **70**,1297-1303(2008).
12. Tusell, L., Legarra, A., García-Tomás, M., Rafel, O., Ramon, J. and Piles, M. Genetic basis of semen traits and their relationship with growth rate in rabbits. *J. ANIM. SCI.,* **90**,1385-1397(2011). http://jas.fass.org/content/early/2011/11/18/jas.2011-4165.
13. Brun, J.M., Sanchez, A., Ailloud, E., Saleil, G. and Theau-Clément, M. Genetic parameters of rabbit semen traits and male fertilizing ability. *Animal Reproduction Science*, **166** (2016) 15–21(2016).
14. Knights, S. A., Baker, R. L., Gianola, D., and Gibb, J. B. Estimates of heritabilities and of genetic and phenotypic correlations among growth and reproductive traits in yearling Angus bulls. *J. Anim. Sci.,* **58**, 887-893(1984).
15. Khalil, H. A., Kishk, W. H., Essa, Omnia M. A. and Awad, M. M. Evaluation of productive and physiological performance of baladi red compared to New Zealand White rabbits under the same managerial conditions. *Egyptian J. Anim. Prod.,* **51 (3)**, 200-209(2014).
16. Brun, J. M., Theau-Clément, M. and Bolet, G. Evidence for heterosis and maternal effects on rabbit semen characteristics. *Anim. Res.,* **51**, 433–442 (2002).
17. Younan, G. E., Hoda E. El-Gabry and Mors, W. A. Semen quality, testosterone level, some enzyme activities, and fertility of male APRI rabbits treated with different levels of olive leaf extract Egyptian. *J. Nutrition and Feeds,* **20** (2) Special Issue, 265-283 (2017).
18. Safaa, H. M., Emarah, M. E. and Saleh, N. F. A. Seasonal effects on semen quality in black baladi and White New Zealand rabbit bucks. *World Rabbit Sci.,* **16**,13-20 (2008).
19. Khalil, H. A., Kishik, W. H., Rabaa, A., Tharwat, Yaseen, M. A., and Ayoub, M. A. Physiological Body Reactions and Semen Characteristics of Rabbit Bucks as Affected by Breed and Vitamin C Supplementation Under Egyptian Summer Conditions. *Journal of Animal, Poultry, and Fish Production.* Suez Canal University (2015).
20. Iraqi, M. M., Radwan, A. A., Gado, M. S., El-Sayed, A. I. and Elokil, A. A. Evaluation of semen characteristics in a project to synthesize a new line of rabbits in Egypt 1st International Conference on Biotechnology Applications in Agriculture, Benha University, Moshtohor, and Hurghada, 18–22 (2012).
21. Isidahomen, C. E. and Oguntade, D. O. Genotype variation in semen, libido, and testicular traits of adult rabbits (Orystolagus cunniculus). *Annual Research & Review in Biology,* **26** (3), 1–5(2018).
22. Younan, G. E., Mervat N. Ghazal, Safaa A. Barakat, Fadila M. Easa, and Samia Z Mesreky Impact of metal, organic, and nanoparticles of copper on semen quality, fertilizing capacity, and liver function in rabbit bucks Egypt. *Poult. Sci.,* **40** (I), 173–190(2020).

23. El-Deghadi, Amira S. (2005). Genetic evaluation for some productive traits in rabbits. Ph.D. Thesis, Faculty of Agriculture, Moshtohor, Zagazig, University, Banha Branch, Egypt.

24. Amin, S. O., El-Sobhy, H. E., El-Fouly, M. A. and El-Sherbiny, A. M. (1987). Effects of season, breed, and sequence of ejaculation on some physical characteristics of rabbit semen *First Conference of Agricultural Development Research Fac. Agric., Ain Shams University, Egypt.*

25. El-Sherbiny, A. M. (1987). Seasonal variation in seminal characteristics of rabbits. Sc. Thesis, Faculty of Agriculture, Ain Shams University, Egypt.

التحليل الوراثي لصفات السائل المنوي في أرانب النيوزيلندي الأبيض والبلدى الأسود

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الملخص

تتوفر معلومات محدودة عن تأثيرالعوامل الوراثية على صفات السائل المنوي لسلالات الارانب المصرية المحلية مقارنة بسلالات الأرانب القياسية. تم تجميع البيانات على 524 قذفًة من 85 ذكر من سلالتى النيوزيلندي الأبيض والبلدى الأسود في عمر 6 أشهر لدراسة صفات السائل المنوي التي تم تحليلها لتقدير المكافىء الوراثى ، والتأثير المشترك لخلفة البطن ، وارتباط الرتب والمظهري ، ودراسة تأثير العوامل غير الوراثية بين الصفات. كانت معظم صفات السائل المنوي متوسطة المكافىء الوراثى (**0.17** إلى **0.32**) باستثناء الحيوانات المنوية الشاذة والحيوانات المنوية الميتة. وكانت التأثيرات البيئية الدائمة معتدلة وعالية (**0.24** إلى **0.73**). كان ارتباط الرتب بين صفات السائل المنوي إيجابيًا وعالى المعنوبة ومرتفعًا بين حجم القذف الكلى وحجم القذف الصافي ؛ وبين حجم القذف الكلى والجيل. و بين حجم القذف الكلى وتركيز الحيوانات المنويةعلى القذفة وبين حجم القذف الصافي والجيل (**0.82** الى **0.98**). كان الارتباط المظهري عالي ومعنويا بين حجم القذف الكلى وحجم القذف الصافي وبين حجم القذف الكلى والجيل وبين حجم القذف الصافي والجيل وبين حجم القذف الكلى وتركيز الحيوانات المنوية (**0.61** الى **0.97**). تفوقت ذكور النيوزيلندي الأبيض فى حجم القذف الكلى و وحجم القذف الصافي والجيل وحركة الحيوانات المنوية الجماعية ، وحركة الحيوانات المنوية التقدمية وتركيز الحيوانات والميت، ودرجة الرغبة الجنسية باستثناء قيمة PH . كان لجميع الصفات التي تم تقييمها اختلافات معنوية لتأثير الأسبوع. لقد أثرت البطن بشكل معنوي على معظم صفات السائل المنوي المدروسة. في فصل الخريف، لاحظنا أقل قيمة للحيوانات المنوية الميتة وأعلى قيم فى حجم القذف الكلى و حجم القذف الصافي والجيل وحركة الحيوانات المنوية الجماعية ، وحركة الحيوانات المنوية التقدمية وتركيز الحيوانات المنوية ودرجة الرغبة الجنسية. ولوحظت أقل القيم لمعظم صفات السائل المنوي خلال فصل الصيف.

الكلمات الدالة: المكافىء الوراثى ، ارتباط الرتب والمظهرى، السلالة، الأسبوع، البطن والموسم.