Evaluation of semen characteristics in a project of synthesizing new line of rabbits in egypt

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Abstract

A total number of 30 bucks in three breed groups of rabbits named Gabali, V-line and Moshtohor line (M-line, as new synthetic line 50% Gabali and 50% V-line)), 10 bucks from each breed group were evaluated in project of synthesizing new rabbit line. Traits of ejaculate volume (EV), semen pH, mass motility (MM), sperm cell concentration (SC), individual motility (IM), live sperm per ejaculate (LS), and sperm abnormalities per ejaculate (SA) were studied. Significant differences for EV, SC, IM, MM, LS, and SA in Gabali, V-line and M-line were detected being 0.60, 0.66 and 0.72 ml for EV, 405.83, 474.48 and 456.1 $x10^6$ for SC, 46.95, 48.63, and 54.82% for IM, 2.26, 2.22 and 2.41 grads for MM, 80.63, 82.38, and 81.99% for LS, 11.79, 12.92, and 12.09% for SA, respectively. No significant differences for semen pH grad due to the effect of breed group. Significant differences for semen pH, EV, SC, IM, MM, LS, and SA in autumn, winter, spring and summer seasons were detected being 7.70, 7.74, 7.79 and 7.75 grad for semen pH, 0.67, 0.65, 0.68 and 0.45 ml for EV, 444.37, 447.72, 446.93 and 442.86 $x10^6$ for SC, 54.53, 57.09, 48.77, and 40.12% for IM, 2.57, 2.73, 2.16 and 1.74 grads for MM, 81.21, 83.24, 84.02 and 77.54% for LS, 11.66, 11.02, 11.48, and 14.92% for SA, respectively. The highest values in semen pH, EV, SC, IM, MM, LS, and SA detected to be semen pH (7.88) appeared during the summer with the M-line, 0.7 ml for EV appeared during the autumn with the V-line, 474.13 $x10^6$ for SC was recorded during the spring with the M-line, 58% for IM was recorded during the autumn with M-Line, 2.81 for MM was recorded during the winter with the Gabali, 87.47% for LS was recorded during the spring with V-line, 16.96% for SA was recorded during the summer with V-line, respectively. Gabali breed had superiority in SC and MM in winter, but V-line had superiority in EV and MM in autumn; SC and LS in spring; and MM in winter. However, M-line had superiority in MM and IM in autumn, semen pH and SC in spring and MM in winter. It could be concluded that the M-line, followed by V-line of buck rabbits could be used as effective indicators for good semen quality. Based on heterosis percentages, it is concluded that M-line bucks had superiority in EV (14.3%), semen pH (0.13%), SC (3.6%), MM (7.6%), IM (14.7%), LS (0.6%) and SA (-2.14%) over the two foundations, which might due to dominance and/or over-dominance genes action at different loci on chromosomes.

Key Words: Rabbits, Gabali, Semen, sperm cell, dominance, over- dominance.

Introduction

Rabbit bucks are considered the basis of the reproductive success in the rabbit production especially when artificial insemination is performed as a routine in the rabbitry (Al-Sobayil and Khalil, 2002). Therefore, crossing between rabbit breeds may be required essentially to show heterotic effects on most economic productive and reproductive parameters. M-Line was founded in 2006 (Iraqi et al., 2010) as a synthesizing line between the Egyptian Sinai Gabali (50%), and the V-Line (50%), (Estany et al., 1989). The procedure of foundation began by mating V line does to Sinai Gabali bucks and it was followed by three generations of "inter se" mating. Afterwards the line has been selected to increase litter weight at weaning and individual weight at 56 day. Several methods have been used for routine analysis of mammalian semen, each describing specific quality criteria of the sperm. Semen analysis is the initial step in the evaluation of male reproductive performance. Standard semen analysis including sperm concentration, motility and morphology is widely used as a fundamental indicator of male fertility. Also, Castellini and Lattaiolip (1999) found that sperm number and number of motile sperms are positively associated with both fertilization rate and embryonic quality. Yousef et al. (2001) reported that it is possible to select bucks as sires for breeding programs depending on number of motile sperm per ejaculate, but not percentage of progressive motility per sires. Semen characteristics vary among seasons. Such variations may be attributed to ambient temperature and length of photoperiod (Amin, *et al.* (1987). Increasing ambient temperature adversely affects semen quality, as well as, by reducing the ability of leydig and sertoli cells to respond to LH and the diameter of the semniferous tubules (El-Sherbiny, 1987). The disorders caused by high ambient temperature are amplified with the increase of relative humidity (Marai *et al*., 2010). Semen evaluation must provide information on the fertilizing ability of spermatozoa. The most relevant

parameters correlated with the fertility rate are the number of spermatozoa inseminated and their motility, although the use of a single attribute is not sufficiently accurate to predict the fertilizing ability of the semen (François *et al.,* 2010). The studies of Marai *et al.* (2010) on rabbits showed that semen-ejaculate volume decreased with the elevation of temperature. On the other hand Tawfeek *et al.* (1994) reported no effect of heat elevation on the semen-ejaculate volume in rabbits. Seleem (2005) stated that the sperm motility is one of the most important characteristics for semen quality. The differences among breeds in sperm motility may be due to the variations in pituitary gland activity that can affect the secretion of luteinizing hormone which affects the secretion of testosterone from the interstitial tissue of the testes. There is a significant positive correlation between the sperm motility and fertility in rabbits. Ayyat and El-Aasar (2008) reported that the sperm motility of buck semen decreased significantly ($p<0.01$) in summer season compared to in winter. There was a higher increase in the estimate of the sperm motility from 64 to 78% in all genetic groups, a finding which might be explained on the fact that semen was collected from bucks in their reproductive seasons. The highest percentage of dead sperms (75%) was recorded during summer and the lowest (24.17%) was obtained during spring season (Tharwat *et al.,* 2004). Khalid and Al-Seaf (2007) found that bucks resulted from crossing V-line with Saudi rabbits seemed to be associated with an improvement in the percentage of sperm livability. The relationship between semen quality and fertility keep in mind the sperm cell concentration as one of the main parameters that indirectly define semen quality (Hagen *et al.,* 2002). The objective of this study was to investigate some semen characteristics for bucks of rabbits in Gabali, V-line and M-line (as new synthetic line, 50% Gabali and 50% V-line) within different seasons of production.

Materials and methods

The number of bucks used in this experiment was ten bucks from the Gabali breed, V-line and M-line rabbits, and all animals were apparently healthy and were about 7 – 12 months old with the average weight of 3.3±0.25 Kg. All bucks in the study were housed in individual cages and trained for artificial seamen collection using the artificial vagina. A female rabbit was used as a teaser. After three weeks of training period, semen was collected in the morning from each buck two ejaculate per month according to Breeder man et al. (1964). Each ejaculate was evaluated manually and examined under the microscope. Semen volume was measured per ml by using a graduated tube directly in the collection. If the ejaculates contain gel excretion, it will be measured and removed (El-Sherbiny, 1987). Initial pH of the semen samples was determined just after collection using comparative paper ranging from 6.0 to 8.1 with 0.3 grades (Whatman pH Indicator paper; Whatman Limited Maidstone, England). Mass motility: A drop of freshly collected semen was placed on a slide kept near body temperature (37-38°C) and was examined under low magnification (X120), motility of semen samples were rated according to the vigor of the motility of sperms (El-Sherbiny, 1987). Percentage of progressive motility of spermatozoa: Immediately after each collection, it was assessed by microscopic examination by placing a small drop of fresh semen on a clean warm glass slide (37- 38°C), diluted with two drops of warm 0.9% NaCl and covered with a cover slip. Examination is made under the high power (x400) according to Soad et al. (1996). Sperm cell concentration ($x10^6$/ml): Semen was diluted 200 times with 0.9% NaCl and one drop eosin, sperm cells concentration in millimeter was estimated haemocytometrically. Examination was made under the high power magnification (X675). Percentages of live spermatozoa (LS %): Differentiation between live and dead spermatozoa was assessed by eosin - nigrosin stain technique. Duplicates smears were made and a total of 200 spermatozoa were counted per each slid using the oil sader (X1350). Live spermatozoa were unstained while dead spermatozoa were stained according to Dott and Faster (1972). Percentage of normal spermatozoa: One smear from each ejaculate was stained with eosin-nigrosin stain and a total of 100 sperms were examined randomly. The percentage of normal sperm was estimated as follows according to Khalifa (1977):

Normal sperm (%) = 100 – Abnormal sperm

Statistical analysis

Data of semen characteristics were analyzed using SAS software, SAS (2004) based on the following model**:**

$$Y_{ijk} = \mu + B_i + S_j + (BS)_{ij} + e_{ijk}$$

Where: Y_{ijk} = the k^{th} observation on the rabbit's buck; μ = common mean; B_i = the fixed effect of the i^{th} breed group; S_j = the fixed effect of the j^{th} season; $(BS)_{ij}$ = the fixed effect of the interaction between the i^{th} breed group and the j^{th} season; and e_{ijk}= the random error associated with the individual observation. The data measured as percentages were subjected to arcsine transformation to approximate normal distribution before being analyzed. Tests of significance for the differences between means were carried out according to Duncan (1955).

Results and discussions

Ejaculate volume

Results presented in Tables 1 and 2 show that there are highly significant differences ($p<0.001$) among the three studied breeds in the ejaculate volume. Means of the ejaculate volume were 0.60, 0.66 and 0.72 ml for the Gabali, V-line and M-line,

respectively. From these results it could point out the superiority of males of Moshtohor line over those the two foundations. Another point of view, the Gabali bucks showed the smallest average of ejaculate volume. This may be due to the Gabali breed has low activity in accessory sex galnds in response testosterone hormone in comparison with the other two breed groups. Results of the present study are in agreement with those reported by Tharwat *et al.* (2004), and Tawfeek *et al.* (2010) who found that, breed have significant effect on ejaculate volume. Conversely, these results disagreed with findings of Seleem (2005) and El-Sbeiy *et al.* (2008) who found that, breed have non-significant effect on ejaculate volume. The variation in the ejaculate volume between breeds may be due to differences in the rate of the accessory sex glands activity in response testosterone hormone (Abd EL-Ghaffar, 1992 and EL-Kamash *et al.*, 2000). It was found that means of ejaculate volume did not showing significant differences due to season effect. Means of the ejaculate volume were 0.67, 0.65, 0.68 and 0.45 ml for the autumn, winter, spring and summer seasons, respectively. Results obtained are in agreement with Seleem (2005) who found that, season have non-significant effect on ejaculate volume. Tharwat *et al.* (1994) found that the greatest ejaculate volume (0.5 ml) was obtained in spring and the smallest (0.2 ml) was obtained in summer. The decrease in the ejaculate volume may be attributed to the effect of high temperature on the level testosterone production and/or secretion which is decreased by increasing ambient the temperature. Ayyat and El-Aasar (2008) reported that during summer, the ejaculate volume of buck semen decreased significantly ($p<0.01$) than in winter. It was shown that the highest ejaculate volume (0.7 ml) was recorded during the autumn season with the V-line, while the lowest one (0.47 ml) was estimated during the summer season with the Gabali breed (Table 1).

Semen pH

Means of semen pH as affected by breed group showed non-significant differences, as well as season effect showed also non-significant differences (Table 1). These means mounted 7.76, 7.72 and 7.75 in Gabali, V-line and M-line; 7.70, 7.74, 7.79 and 7.75 in autumn, winter, spring and summer seasons, respectively. The interaction between breed group and season effects has no significant affect on the pH of semen's buck. It was found that the highest pH value (7.88) appeared during the spring season for M-line, while the lowest value (7.62) appeared during the autumn season with M-line. These differences may be attributed to the differences in environmental temperature among season. The measurements of semen pH is of great importance because any semen extender used should be of approximate similar pH value as semen or should act as a buffer against excessive acidity or alkalinity and also, it acts as an indicator for the normal accessory glands secretion and the livability of spermatozoa (Abd EL-Ghaffar, 1992). So, pH is considered a good indicator for semen quality.

Sperm cell concentration ($x10^6$)

Means of sperm cell concentration ($x10^6$) as affected by breed group of the buck were 405.83, 474.48 and 456.11 for Gabali, V-line and M-line, respectively (Table 1). Analysis of variance for data obtained reviled highly significant differences ($P<0.0001$) among the three breed groups and the superiority of V-line and M-line against the Gabali breed was dearly evident (Table 2). The variation in the sperm cell concentration may be due to difference within the breeds, age, environmental conditions, testosterone level, the body size and testicular weight (Abd EL-Ghaffar, 1992). These findings are in agreement with those of Al-Sobayil and Khalil (2002) and Seleem (2005). Most of these studies showed significant effects of breeds on sperm-cell concentration per ml.

Table 1. Least square means[+] and standard errors for factors affecting ejaculate volume (ml), semen pH and sperm cell concentration ($x10^6$) in rabbit bucks.

Classification	No. of Obs.	Ejaculate volume, ml	Semen pH	Concentration, $x10^6$
Breed group (B):				
Gabali	240	0.60 ± 0.01^{b}	7.76 ± 0.03	405.83 ± 4.2^{c}
V-line	240	0.66 ± 0.01^{a}	7.72 ± 0.03	474.48 ± 4.3^{a}
M-line	240	0.72 ± 0.01^{a}	7.75 ± 0.03	456.11 ± 4.2^{b}
Heterosis (%)[++]		14.30	0.13	3.60
Season (S):				
Autumn	180	0.67 ± 0.01	7.70 ± 0.03	444.37 ± 4.6^{a}
Winter	180	0.65 ± 0.01	7.74 ± 0.03	447.72 ± 5.6^{a}
Spring	180	0.68 ± 0.01	7.79 ± 0.03	446.93 ± 5.2^{a}
Summer	180	0.45 ± 0.01	7.75 ± 0.03	442.86 ± 3.8^{b}
Interaction of (BxS):				
Gabali x autumn	60	0.62 ± 0.02^{bcd}	7.70 ± 0.05	461.38 ± 11.54^{ab}
Gabali x winter	60	0.61 ± 0.02^{cd}	7.77 ± 0.05	478.75 ± 9.17^{a}

Table 1. cont.

Gabali x spring	60	0.62±0.02^{bcd}	7.72±0.06	423.72±8.94^{cd}
Gabali x	60	0.47±0.02^{e}	7.75±0.06	403.05±8.66^{de}
V-line x autumn	60	0.70±0.02^{a}	7.66±0.06	470.18±9.10^{a}
V-line x winter	60	0.67±0.01^{b}	7.76±0.04	442.17±8.86^{ab}
V-line x spring	60	0.66±0.02^{bc}	7.77±0.06	474.91±9.61^{a}
V-line x	60	0.49±0.02^{e}	7.71±0.06	393.38±7.44^{e}
M-line x	60	0.67±0.02^{bc}	7.62±0.04	459.80±6.79^{ab}
M-line x winter	60	0.67±0.01^{bc}	7.71±0.04	461.10±6.09^{ab}
M-line x spring	60	0.67±0.02^{a}	7.88±0.06	474.13±6.53^{a}
M-line x	60	0.56±0.02^{d}	7.80±0.08	400.15±8.40^{de}

[+] Means with different superscript in the same column within each effect are significantly different at ($p<0.05$).
[++] Heterosis percentages were computed as: {(average of M-line – (average of the Gabali and V-line)) / (average of the Gabali and V-line)} x 100.

Table 2. F-ratios of least square analysis for factors affecting semen pH, ejaculate volume (ml) and sperm cell concentration (x10^6) in rabbit bucks.

S .O. V	d.f.	Ejaculate volume, ml	Semen pH	Concentration, x10^6
Breed group (B)	2	18.95****	0.41$^{n.s}$	85.05****
Season (S)	3	0.61$^{n.s}$	1.17$^{n.s}$	3.03**
Interaction of (BxS)	6	2.66**	1.70$^{n.s}$	1.68*
Error d.f.	708	4.43	1.42	19.68
Error MS		0.105	0.24	32.92

n.s = non significant, * = $p<0.05$** = $p<0.01$ and ****= $p<0.0001$.

Results obtained in (Table 1) showed highly significant differences ($p<0.01$) in the sperm cell concentration (x10^6) of buck semen among the four seasons. The sperm cell concentration means were 444.37, 447.72, 446.93 and 442.86 for autumn, winter, spring and summer seasons, respectively. The lower value of sperm cell concentration (x10^6) associated with the hot climate could be attributed to the decline in levels of testosterone and gonadotrophins essential for maintaining the testicular sperm producing potential (Ayyat and El-Aasar, 2008). These results are in agreement with findings of El-Sherbiny (1987) and Daader *et al. (*1999) who revealed that total-sperm output values were significantly higher in winter than in summer. Zeidan *et al*. (1997) stated that the decrease in sperm cell concentration might be attributed to the degeneration of germinal epithelium and atrophy of the semniferous tubules. High ambient temperature was found to affect the total sperm production (Ahmed *et al*., 2006). This could be attributed to a decrease in the activity of sertoli cells which in turn affects daily spermatogenesis. Data presented in Table 1 show that the highest sperm cell concentration (474.13) recorded during the spring season with the M-line, while the lowest average (393.38) was recorded during the summer season with the V-line, respectively. This reflects the superiority of the crossbred line of Moshtohor by 3.6% over the two foundations indicating good semen quality of Moshtohor bucks that have indirect relationship with the buck fertility. The relationship between semen quality and fertility keep in mind the sperm cell concentration as one of the main parameters that indirectly define semen quality (Hagen *et al.,* 2002). Mass motility score (0-5): Data obtained in (Table 4) showed highly significant differences ($p<0.01$) due to breed group effect with means of 2.26, 2.22 and 2.41 in Gabali, V-line and M-line, respectively. This indicates that superiority of the crossbred line of Moshtohor by 7.6% over the two foundations. These findings are in agreement with those of Khalil (1999) and EL-Kamash et al. (2000), who concluded that sperm motility differs between different breeds of rabbits. These differences in sperm motility may be due to the variations in pituitary gland activity that can affect the secretion of luteinizing hormone (LH) which affects the secretion of testosterone from the interstitial tissue (Leydig cells) of the testes (Seleem, 2005). Data concerning the effect of season on mass motility means presented in Table 3 revealed that average of mass motility mounted 2.57, 2.73, 2.16 and 1.74 for autumn, winter, spring and summer seasons, respectively. It is showed highly significant differences ($p<0.01$) due to the effect of seasons (Table 4). The highest means were recorded in autumn and winter while the lowest ones (1.74) were in summer season which could be due to high environmental temperature. These findings are in agreement with those of Tharwat *et al.* (1994) and El-Maghawry and Soliman (2002) who reported that

hot environment in summer have adverse effect on mass and progressive sperm motility. Results obtained in Table 3 show that the highest mass motility average in summer season was recorded for M-line (1.88, $p<0.05$), followed by Gabali breed (1.73), while the lowest ones was recorded for V-line (1.61). This indicates that Moshtohor line has more adaptation ($p<0.05$) with hot climate conditions in summer than the two foundations for mass motility of sperm. This could be due to genetic progress by crossing Gabali with V-line (Khalil, 1996). Individual motility (%): Advanced motility illustrates the sperm activity degree and its importance for passing throws the oviduct and completing fertilization (EL-Darawany and EL-Sayiad, 1995). Results obtained showed highly significant differences ($p<0.01$) due to breed group effect (Table 4) having means of 46.95, 48.63, and 54.82% for Gabali, V-line and M-line, respectively (Table 3). This reflect the superiority of the crossbred line (Moshtohor) over the other breeds by 14.7% which indicate good advanced motility of Moshtohor bucks that have direct relationship with the buck fertility. Many workers noticed that breed has significant effect on the individual motility of sperms (Tharwat et al., 2004 and Seleem, 2005). Mass and individual sperm motilities in Gabali (1.44 and 50%, resp.) were lower than those of New Zealand White (2.82% and 55%, resp.) rabbits (Khalil, 1999). Results obtained allowed that average of individual motility mounted 54.53, 57.09, 48.77, and 40.12% for autumn, winter, spring and summer seasons, respectively, showed highly significant differences ($p<0.01$) among the four seasons (Table 4). The best means were recorded in autumn, winter while the lowest values were recorded during the summer season that could be due to high environmental temperature. These findings are in agreement with those of Amin et al. (1987) who found that, season have significant effect on individual sperm motility. The individual sperm motility of buck semen was noticed to be significantly ($p<0.05$) lowered (37.1%) during the period of high ambient temperature than those (81.1%) during the period of low ambient temperature as reported by Ahmed *et al*. (2006). Ayyat and El-Aasar (2008) reported that during summer, the sperm motility of buck semen decreased significantly ($p<0.01$) than in winter season. Results in Table 3 showed that the highest individual motility average in summer season was recorded for M-line (44.58%), followed by V-line (39.78%), while the lowest ones was recorded for Gabali breed (33.96%). This indicates that Moshtohor line has more adaptation ($p<0.05$) with hot climate conditions in summer than the two foundations for individaul motility of sperm. This could be due to genetic progress by crossing Gabali with V-line (Khalil, 1996). Live sperm per ejaculate: It was found that means of live sperm per ejaculate were 80.63, 82.38, and 81.99% for Gabali, V-line and M-line, respectively (Table 3). This reflects the superiority of the crossbred line of Moshtohor by 0.6% over the two foundations. Such breed differences in live sperm percentage was also reported by EL-Sherbiny (1987). Khalil (1996) reported that the percentage of dead sperm was lower in Gabali (21%) than that in New Zealand White (24%) rabbits. Khalid *et al*. (2009) found that bucks resulted from crossing V-line with Saudi rabbits seemed to be associated with an improvement in the percentage of sperm livability. Results obtained in Table 3&4 showed that average of live sperm per ejaculate were 81.21, 83.24, 84.02 and 77.54% for autumn, winter, spring and summer seasons, respectively which showed highly significant differences ($p<0.01$) due to the effect of four seasons. The highest means were recorded in spring and winter while the lowest value (77.54%) was recorded during the summer season due to the negative and deleterious effects of high environmental temperature. These results in agreement with the finding of El-Maghawry and Soliman (2002), they attributed the low percentage of dead sperms during spring under Egyptian condition to the suitable environmental conditions. The percentage of dead spermatozoa was significantly ($p<0.05$) higher during the period of high ambient temperature (Ahmed *et al.,* 2006). The highest live sperm per ejaculate (87.47%) was recorded during the spring season with V-line, while the lowest (75.94%) was recorded during the summer season with the V-line also. These results show that V-line bucks were more sensitive to the increase of ambient temperature. On the other hand, line sperm in summer season was recorded for M-line (79.0%), followed by Gabali breed (76.87%) and the lowest one recorded for V-line (75.94%). This indicates that Moshtohor line has more adaptation ($p<0.05$) with hot climate conditions in summer than the two foundations for live sperm. This could be due to genetic progress by crossing Gabali with V-line (Khalil, 1996). Sperm abnormalities per ejaculate percentage: Significant differences ($p<0.0001$) was observed, among breed group effects with means of 11.79, 12.92 and 12.09% for Gabali, V-line and M-line, respectively. This reflects the superiority of the crossbred line of Moshtohor by -2.14% for sperm abnormalities over than the two foundations. The percentage of sperm abnormalities per ejaculate are in positive relationship with the sperm cell concentration as shown the smallest concentration in Gabali bucks semen correlated with the smallest percent of abnormal sperms. It is important to notice that the presence of large number of abnormal spermatozoa in semen seem to decrease its fertility. This fact is in agreement with that of Afifi (1997) who revealed that percentage of abnormal sperm in Gabali (20%) was lower than that in New Zealand White (22%) and Baladi (23%) but higher than that in Californian (18%) and Giza White (17%) rabbits. Tawfeek *et al.* (2010) found significant differences in

percentages of normal spermatozoa due to breeds, while other investigations revealed non-significant differences in percentages of normal spermatozoa among different breeds of rabbits (El-Darawany and EL-Sayied, 1995 and Daader *et al.,* 1999). Average of sperm abnormalities (%) mounted 11.66, 11.02, 11.48, and 14.92 % for autumn, winter, spring and summer seasons, respectively, showed highly significant differences ($p<0.01$) among the four seasons (Table, 4). Increasing of sperm abnormalities per ejaculate was found in summer (14.92%) which was higher than the other seasons this may be attributed to the negative and deleterious effects of high environmental temperature during the summer season. During summer, the percentage of abnormal spermatozoa of buck semen increased significantly ($p<0.01$) than in winter (Seleem, 2005). The interaction between breed and season affected average of the sperm abnormalities per ejaculate. The highest sperm abnormalities per ejaculate average 16.96% was recorded during the summer season with V-line, while the lowest average 10.67% was recorded during the spring season with the Gabali breed. This result show that V-line bucks were more sensitive to the increase in ambient temperature and should to be reared in optimum conditions and to be avoided of heat stress while Gabali (as a local breed) is more adapted to hot climate conditions but still in demand of genetic selection and improvement of managerial procedures.

Conclusion

The M-line and V-line of buck rabbits could be used as effective indicators for good semen quality. Based on heterosis percentages, it is recommended that the M-line bucks had superiority in all the studied semen characteristics which might due to dominance and/or over-dominance genes action at different loci on chromosomes.

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Table (3). Least square means[+] and standard errors for factors affecting mass motility, grade, individual sperm motility, live sperm/ejaculate %, and sperm abnormalities /ejaculate % in rabbit bucks.

Classification	No. of Observation	Mass motility, grade	Individual sperm motility, %	Live sperm/ ejaculate,%	Sperm abnormalities/ ejaculate,%
Breed group (B):					
Gabali	240	2.26 ± 0.04^{b}	46.95 ± 0.7^{b}	80.63 ± 0.25^{c}	11.79 ± 0.14^{b}
V-line	240	2.22 ± 0.04^{b}	48.63 ± 0.7^{b}	82.38 ± 0.26^{a}	12.92 ± 0.14^{a}
M-Line	240	2.41 ± 0.04^{a}	54.82 ± 0.7^{a}	81.99 ± 0.25^{b}	12.09 ± 0.14^{b}
Heterosis (%)[++]		7.6	14.7	0.6	-2.14
Season (S):					
Autumn	180	2.57 ± 0.04^{a}	54.53 ± 0.8^{a}	81.21 ± 0.27^{b}	11.66 ± 0.15^{b}
Winter	180	2.73 ± 0.04^{a}	57.09 ± 0.7^{a}	83.24 ± 0.23^{a}	11.02 ± 0.12^{c}
Spring	180	2.16 ± 0.05^{b}	48.77 ± 0.9^{b}	84.02 ± 0.31^{a}	11.48 ± 0.17^{bc}
Summer	180	1.74 ± 0.06^{c}	40.12 ± 1.0^{c}	77.54 ± 0.34^{c}	14.92 ± 0.18^{a}
Interaction of (B*S):					
Gabali x autumn	60	2.26 ± 0.08^{b}	55.02 ± 1.47^{b}	81.52 ± 0.48^{cd}	11.17 ± 0.26^{bef}
Gabali x winter	60	2.81 ± 0.07^{a}	57.75 ± 1.37^{ab}	82.23 ± 0.44^{c}	10.71 ± 0.24^{f}
Gabali x spring	60	2.25 ± 0.09^{b}	41.02 ± 1.64^{d}	81.91 ± 0.53^{cd}	10.67 ± 0.29^{f}
Gabali x	60	1.73 ± 0.09^{cd}	33.96 ± 1.59^{e}	76.87 ± 0.52^{f}	14.52 ± 0.28^{b}
V-line x autumn	60	2.69 ± 0.09^{a}	48.59 ± 1.67^{c}	81.67 ± 0.55^{cd}	11.81 ± 0.30^{d}
V-line x winter	60	2.63 ± 0.07^{a}	55.52 ± 1.19^{ab}	84.46 ± 0.39^{b}	11.44 ± 0.41^{def}
V-line x spring	60	1.97 ± 0.10^{c}	48.62 ± 1.76^{c}	87.47 ± 0.58^{a}	11.76 ± 0.32^{de}
V-line x summer	60	1.61 ± 0.09^{d}	39.78 ± 1.69^{d}	75.94 ± 0.56^{f}	16.96 ± 0.30^{a}
M-line x autumn	60	2.76 ± 0.07^{a}	58.00 ± 1.24^{a}	80.46 ± 0.41^{de}	12.01 ± 0.22^{d}
M-line x winter	60	2.76 ± 0.06^{a}	57.90 ± 1.12^{ab}	83.03 ± 0.36^{c}	10.92 ± 0.20^{ef}
M-line x spring	60	2.26 ± 0.09^{b}	56.67 ± 1.62^{ab}	82.68 ± 0.53^{c}	11.92 ± 0.29^{d}
M-line x	60	1.88 ± 0.10^{c}	44.58 ± 2.11^{cd}	79.80 ± 0.69^{e}	13.55 ± 0.38^{c}

[+] Means with different superscript in the same column within each effect are significantly different at ($p<0.05$).

[++] Heterosis percentages were computed as: {(average of M-line – (average of the Gabali and V-line)) / (average of the Gabali and V-line)} x 100.

Table (4). F- ratios of least square analysis for factors affecting mass motility, grade, individual sperm motility, live sperm/ejaculate %, and sperm abnormalities/ejaculate % in rabbit bucks.

S .O. V	d.f.	Mass motility, grade	Individual sperm motility, %	Live sperm/ ejaculate, %	Sperm abnormalities/ ejaculate, %
Breed group (B)	2	4.97***	28.23***	11.70***	16.87****
Season (S)	3	70.80****	67.08****	81.87****	102.82****
Interaction of (BxS)	6	3.84****	8.35****	11.72****	6.09****
Error d.f.	708				
Error MS		0.54	159.29	17.17	5.26

*** = p<0.001 and ****= p<0.0001.

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