Egyptian J. Anim. Prod. (2025) 62(1):61-67

THE CHANGES IN EPIDIDYMAL CAMEL SPERMATOZOA AS AFFECTED BY GREEN LASER IRRADIATION

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Article History: Received: 5/3/2025; Accepted: 14/4/2025; Published: 19/4/2025
DOI: 10.21608/ejap.2025.365609.1108

SUMMARY

Twenty Sudan camels (Camelus dromedarius) with forty testes were applied in this study. The aim of this research was to determine the impact of short-wave length green laser irradiation at various times from 0 to 10 minutes on epididymal spermatozoa quality in camel. After exposure of laser, motile, viable, acrosomal damage of spermatozoa (%), AST, ALT and ALP enzymes activity were determined under the incubation at 37°C for 8hours. The penetrating ability of spermatozoa that exposed to laser irradiation for various times into she-camel cervical mucus at 37°C for 4 hours was also checked. The achieved results displayed that exposure to 6 min of laser achieved the highest percentage of motile spermatozoa. While, exposure to 2 min achieved the lowest percentages of dead spermatozoa, acrosomal damage, AST, ALT and ALP enzymes. The advancement of incubation time reduced (P<0.05) motile spermatozoa (%). Meanwhile, increased dead spermatozoa (%), acrosomal damage (%), AST, ALT and ALP enzymes. The penetrating ability of spermatozoa into cervical mucus was better (P<0.05) at all groups than the control group during incubation. In conclusion, laser irradiation may be considered as a cheap and effective technique for improving the quality of camel semen by increasing the percentages of motile spermatozoa, livability, acrosomal integrity which can be used as an indicator to enhance the function of mitochondriato extend the survival of spermatozoa.

Keywords: Camel, epididymal spermatozoa, greenlaser irradiation, incubation

INTRODUCTION

The camel is considered an agricultural animal that is exclusively suitable to arid regions. In Africa, the population growth together with a drop in food production requires the emergency need to cultivate formerly underused resources and maximize their use through the production systems of livestock in which camel husbandry is definitely one of the best. Nevertheless, plentiful and complex ecological constraints may negatively influence reproductive performance of dromedary camel (El-Hassanein *et al.*, 2004).

Artificial insemination (AI) has been quite rapidly gaining recognition as a valuable practice for disseminating farm animal genetics through breeding programs in the 21st century. Such advancement in AI, semen preservation and related practices of camel's reproduction has lagged behind that of other livestock due to limitation of sperm collection, scanty literature on semen quality, practices of semen separation, and semen preservation. A number of elements may be accountable for the progressive decline in assimilating capacity of the chimeric spermatozoon when subjected to integration under particular conditions (Anand, 1979). For this specific reason, it is important to seek alternate approaches that are less invasive and seek to enhance mitochondrial activity in sperm.

The 20th century has seen a lot of research on the effect of laser on biological tissues. It has been brought forth quite clearly, that laser radiation has biological effects. Sperm motility has been shown to be enhanced by low exposure of spermatozoa to helium-neon laser (Karu, 2012). The initial instance of exposure to laser being used to enhance semen quality was reported by Goldstein (1969), this has been done in many species such as human (Pareek *et al.*, 2023), mouse (Cohen *et al.*, 1998), sheep (Zan-Bar *et al.*, 2005), dog (CorralBaqués *et al.*, 2009), and rabbit (Iaffaldano *et al.*, 2010) semen. Therefore, the present study aims to determine the possible consequences of laser exposure with a 532 nm from 0 to 10 minutes on the quality of spermatozoa at 37°C for eight hours in dromedary camels.

MATERIALS AND METHODS

This research was conducted in the Embryo Transfer Laboratory, Artificial Insemination and Embryo Transfer Department, Animal Reproduction Research Institute, Agricultural Research Center, Giza, Egypt, along with Laser Atomic Spectroscopy Laboratory, Laser Applications in Metrology, Photochemistry and Agriculture Department, National Institute of Laser Enhanced Sciences, Cairo University, Giza, Egypt.

Experimental animals:

The research involved a set of 20 normal Sudani camels with forty testes obtained from them, more than 5 to 10 years or older, and weighed 500-600 kg of body weight obtained from automatized El-Basateen slaughterhouse, Cairo, Egypt during October to December with 10 replicates.

Samples transportation:

Epididymides with the testes which were together with other parts of the carcass had been brought into the thermos containing sterile 0.9% saline solutions mixed with 100 µg/ml of streptomycin and maintained at 25 degree Celsius as described by Goto *et al.* (1989) within two to three hours post slaughter.

Sperm recovery:

After fortifying all defeat testes, the fluid (blood) was soaked up by pressing the superficial cut veins around the cauda tested tissues. Epididymis was separated by a sterile scalpel and forceps into three parts as caput, corpus and cauda in order and placed in three sections of 100 mm in diameter of Petri dish containing saline solution.

Semen extension:

Sperm cells from the epidydymis of camel males were collected and evaluated before being pooled together. The sperm was diluted with the dilution described by Musa *et al.* (1992), which included lactose-yolk-citrate (sodium citrate as 2.9 g, citric acid as 0.04 g, lactose as 1.25 g and egg-yolk as 10 ml) completed to 100 ml of distilled water. Penicillin as 500 I.U/ml with streptomycin sulphateas 500 µg were added.

Incubation of semen at 37°C:

In this study, six groups of semen in the irradiation treatment were divided into non-irradiated group (control group) and five irradiation groups of laser through two to 10 minutes and were preserved by incubating at 37°Cfor a maximum duration of eight hours. Motility, viability and acrosome integrity (%) after incubation was recorded at various exposure periods of laser irradiation from zero to 10 minutes. The enzymatic activity was also measured at incubation form zero till eight hours.

Evaluation of semen:

Sperm motility (%):

Motile spermatozoa (%) were identified as a wavy direction of the flagellum because of high viscosity in camel semen **(**Tibary and Anouassi, 1997).

Dead spermatozoa (%):

As mentioned by Hackett and Macpherson (1965), the eosin/nigrosin stain was used, eosin as 1.67 g and nigrosin as10 g were dissolved in 100 ml of distilled water.

Acrosomal damage of spermatozoa (%):

As described by Watson (1975), acrosomal damage (%) was determined with staining with try pan blue 2% (T-0887 Sigma) to check viable sperm and 40 minutes with Giemsa 10% (Merck, Darmstadt, Germany) in distilled water.

Enzymatic activity (U/10^6 spermatozoa):

Centrifugation of semen samples at 600 g for 15 min was assessed. Following collection of the supernatant fluid, it was stored at -20°C until AST, ALT, and ALP enzymes were analyzed. AST, ALT, and ALP enzymes activity were set based on sperm cell content (U/10^6 spermatozoa) as described by Reitman and Frankle (1957). Enzymaticactivity was measured colorimetrically using a QCA kit from Amposta, Spain.

Sperm penetration (Score):

Sperm penetration into cervical mucus of she-camel with or without exposure to laser irradiation was estimated as follows: Cervical mucus of she-camel was obtained at age>5-10 years. Sealed tubes with polyethylene were set with internal diameter of two mm for sucking a portion of the obtained mucus to give a column with six cm in length. Following semen collection, lactose-yolk-citrate (LYC) extender was used to extend camel semen as mentioned by Salisbury *et al.* (1978) and divided into a control group and five irradiated groups with laser for two, four, six, eight and 10 min. Each group of semen was placed into two ml cuvettes (one ml each). The tubes contained the mucus were insured into the diluted semen and incubated at 37°C for four hours. As reported by Eskin *et al.* (1973) and Hanson *et al.* (1982), penetration was recorded as a rank score.

Laser irradiation parameters:

For spermatozoa irradiation from 0 to 10 min, a green laser with a short wave-length of λ=532 nmwith 3 mWas an output power was used. Laser parameters are shown in **Table (1)**. The used irradiance was determinedas reported by**Calderhead (1990)** as follows:

$$Irradiance = \frac{Output\ of\ power\ (mW)}{Surface\ of\ application\ (cm^2)}$$

Table 1. Times of laser exposure and fluency

Fluency (J/cm^2)	Output (mW)	Time (min)	Wavelength (nm), (Colour)
0.38	3	0 to 10	532 (Green)

Statistical analysis:

The data was statistically analyzed using two-way ANOVA and the SAS General Linear Model (GLM) technique **(**SAS, 2000). To identify significant differences among means, Duncan's Multiple Range Test was used (Duncan, 1955). Prior to statistical

analysis, percentage values were converted to arc-sin values. The used statistical model was shown with this model:

$$Y_{ijk} = \mu + L_i + I_j + (L \times I)_{ij} + e_{ijk}$$

Where,

Y_{ijk}= the observed value of the dependent variable obtained from spermatozoa.

μ = the overall mean.

L_i= the fixed effect of the i^{th} durations of laser exposure(min), i= 0 to 10.

I_j = the fixed effect of j^{th} time of incubation (hours), j = 0 to 8.

$(L \times I)_{ij}$= the interaction between the durations of laser exposure (min) and the time of incubation (hours).

e_{ijk} = the residual error.

RESULTS AND DISCUSSION

Sperm motility (%):

Table (2) showed that motile spermatozoa (%) at 37°C (P<0.05) was increased by green laser irradiation at 532 nm, three mW for six min compared to the control. This is consistent with Nicolae *et al.* (2015), who reported that motile and viable spermatozoa, function of mitochondria and response of hypo-osmotic swelling at 6.12 J/cm^2 increased by exposure to He-Ne laser irradiation in ram. Whereas, the quality of seminal attributes decreased compared to the control group with exposure toa dose of 3.96 J/cm^2. The same trend was reported by Iaffaldano *et al.* (2016) who stated an increase (P<0.05) in motile and viable spermatozoa at 6.12 J/cm^2 by irradiating frozen-thawed semen in ram with exposure to He-Ne laser at four and nine J/cm^2.Similar results were obtained by Ahmed *et al.* (2024) in human semen and Abdalla *et al*. (2021) in camels. Lone *et al.* (2018) reported that enhancement in semen quality may be due to the interaction between the mitochondria and irradiation, where irradiated spermatozoa have high contents of the activity of cytochrome C oxidase (COX) and ATP than non-irradiated in which COX and ATP were high correlated. Also, a positive significant correlation between the activity of COX, the level of ATP and sperm motility was determined.

Table (2) showed that motile spermatozoa (%) was (P<0.05) reduced by the extension of preservation time at 37°C for 8hoursat all times of exposure to laser including the control group. This may be due to the increase of the production of lactic acid which leads to a toxic effect on the sperm as a result of the high metabolic activity of spermatozoa. In a similar result, Abd El-Salaam *et al.* (2012) reported that preservation at 37°C for 12 hours (P<0.01) decreased sperm motility (%) in camel. Meanwhile, an insignificant interaction was observed between preservation time and exposure to laser on motile spermatozoa.

Table 2. Mean percentage of motile spermatozoa, with exposure to laser during preservation at 37˚C in camels

Incubation time (hours)	Time of exposure (min)						Mean±SE
	Control	2	4	6	8	10	
0	50.56±1.55	52.22±1.21	58.89±2.16	70.56±1.00	69.44±1.30	63.89±1.39	60.93^{A}±1.21
1	40.00±1.44	46.11±1.11	51.67±1.44	65.56±0.56	63.89±0.73	58.33±0.17	54.26^{B}±1.34
2	34.44±1.30	40.56±1.30	45.56±1.55	56.67±1.86	55.00±1.67	52.22±1.21	47.41^{C}±1.25
4	30.00±0.83	34.44±1.00	41.67±1.44	53.33±1.17	51.11±1.11	46.11±1.11	42.78^{D}±1.24
6	25.00±1.17	33.33±1.17	37.78±0.87	46.67±1.17	44.44±1.30	40.00±0.83	37.87^{E}±1.07
8	21.11±0.73	30.00±0.00	33.33±1.17	41.67±0.83	38.89±1.11	33.89±1.39	33.15^{F}±0.98
Overall mean	33.52^{f}±1.42	39.44^{e}±1.14	44.81^{d}±1.31	55.74^{a}±1.45	53.79^{b}±1.52	49.07^{c}±1.48	46.06

$^{A-F}$Different superscripts values within a column are significantly different (P<0.05).

$^{a-f}$Different superscripts values within a row are significantly different (P<0.05).

Dead spermatozoa (%):

Compared to other exposure times and the control, dead spermatozoa (%)was (P<0.05) higher with exposure to laser for 10 min during incubation at 37˚C **(**Table, 3),where (P<0.05) were decreased with exposure to laser for two, four and six min with 47.41, 49.07, and 54.44%, respectively than the control group (57.96%).In this regard, Iaffaldano *et al.* (2010 and 2016), reported a higher (P<0.05)percentage of viable spermatozoa 1 day post storage at 6.0 and 9.0 J/cm^{2}of laser irradiation than the control in rabbit semen. The same trend was observed by Nicolae *et al.* (2015) who reported an increase (P<0.05) in the viable spermatozoa (%) with exposure to laser with 6.12 J/cm^2 than 3.96 J/cm^2 in ram semen.

The dead spermatozoa (%) was (P<0.05) increased by the prolongation of preservation time at all times of exposure to laser including the control in camel semen (Table, 3). Abd El-Salaam *et al.* (2012) was also reported a similar trend in the camel semen, in which the dead spermatozoa (%) was (P<0.05) increased by the prolongation of preservation time for 12 hours at 37°C. An insignificant interaction between preservation time and exposure to laser was observed on dead spermatozoa.

Table 3. Mean percentage of dead spermatozoa, with exposure to laser during preservation at 37°C in camels

Incubation time (hours)	Time of exposure (min)						Mean±SE
	Control	2	4	6	8	10	
0	36.67±1.67	28.89±2.00	30.56±2.27	34.44±1.94	36.67±2.04	43.33±1.86	35.09^{F}±1.00
1	46.67±1.67	36.11±1.39	37.22±1.68	42.78±1.68	45.00±1.86	50.56±1.94	43.06^{E}±0.96
2	54.44±1.30	43.89±2.00	46.67±2.35	52.22±1.68	55.56±1.94	61.67±1.86	52.41^{D}±1.08
4	62.22±1.68	48.89±2.00	52.78±1.68	58.33±1.67	61.67±1.67	67.78±1.21	58.61^{C}±1.07
6	70.00±1.67	58.89±2.00	58.89±2.00	66.11±1.39	67.78±1.46	72.22±1.68	65.65^{B}±0.97
8	77.78±1.46	67.78±1.46	68.33±1.17	72.78±1.88	77.78±1.46	78.89±1.11	73.89^{A}±0.84
Overall mean	57.96^{b}±1.99	47.41^{d}±1.94	49.07^{d}±1.89	54.44^{c}±1.92	57.41±2.00	62.41^{a}±1.80	54.78

$^{A-E}$Different superscripts values within a column are significantly different (P<0.05).
$^{a-d}$Different superscripts values within a row are significantly different (P<0.05).

Acrosomal damage of spermatozoa (%):

Spermatozoa exposed to 10 min of irradiation were (P<0.05) higher in the percentage of acrosomal damage comparing to other groups including the control **(**Table, 4). Exposing spermatozoa to two and four min of laser (P<0.05) lowered the percentage of acrosomal damage with 23.22 and 24.07%, respectively comparing to the control group (25.76%). In a similar trend, an increase in sperm motility was observed with no changes in acrosome integrity and sperm viability in the boar (Yeste *et al.*, 2016), in which semen quality parameters were significantly low in non-irradiated spermatozoa comparing to irradiated spermatozoa after 90 min of incubation at 37ºC.

The acrosomal damage (%) was (P<0.05) increased by the increase of preservation at 37°Cfor 8hoursat all groups including the control group (Table, 4). This finding is in agreement with Abd El-Salaam *et al.* (2012), in which dead spermatozoa (%) was (P<0.05) increased with increasing the preservation time 12 hours at 37°C in the camel semen. An insignificant interaction between preservation time at 37°C and exposure to laser was observed on acrosomal damage.

Table 4. Mean percentage of acrosomal damage of spermatozoa, with exposure to laser during preservation at 37°C in camels

Incubation time (hours)	Time of exposure (min)						Mean±SE
	Control	2	4	6	8	10	
0	20.22±0.57	18.56±0.50	18.78±0.57	20.11±0.58	20.44±0.60	22.33±0.75	20.07^{F}±0.28
1	22.22±0.57	19.78±0.55	20.33±0.65	21.44±0.66	22.11±0.72	24.11±0.67	21.67^{E}±0.32
2	24.11±0.63	21.67±0.73	22.44±0.73	23.44±0.63	24.00±0.75	26.33±0.82	23.67^{D}±0.34
4	26.78±0.64	24.22±0.74	25.11±0.58	26.11±0.81	26.89±0.63	29.33±0.85	26.41^{C}±0.35
6	29.22±0.64	26.44±0.47	27.11±0.69	28.56±0.58	28.89±0.67	31.78±0.87	28.67^{B}±0.35
8	32.00±0.85	28.67±0.68	30.67±1.30	31.22±0.89	32.11±0.87	34.11±0.92	31.46^{A}±0.43
Overall mean	25.76^{b}±0.61	23.22^{d}±0.55	24.07^{c}±0.64	25.15^{b}±0.60	25.74^{b}±0.62	28.00^{a}±0.65	25.32

$^{A-F}$Different superscripts values within a column are significantly different (P<0.05).
$^{a-d}$Different superscripts values within a row are significantly different (P<0.05).

Enzymatic activity (U/10^6 spermatozoa):

Spermatozoa that exposed to 10 min of laser were (P<0.05) higher in the activity of AST and ALT enzymes comparing to other groups including the control (Tables, 5-6), respectively. While, exposing spermatozoa to eight and 10 min of laser leaded to (P<0.05) increase in the activity of ALP enzyme comparing to other groups including the control (Table, 7). This could be a reason to the breakdown of the cellular sperm membrane which leads to the increase in intracellular leakage of AST, ALT and ALP enzymes as a result of long times of exposure to laser irradiation.

The infiltration of the enzymes into the extra cellular media was (P<0.05) increased by increasing the preservation at 37°C for eight hours at all groups including the control (Tables, 5-7), respectively. The findings of Abd El-Salaam *et al.* (2012) are in agreement with the present results, in which these released enzymes were (P<0.05) increased by increasing the preservation time for 12 hours at 37°C in camel semen. Also, an insignificant interaction was observed between preservation time at 37°C and exposure to laser on the enzymatic activity.

Table 5. Activity of AST enzyme (U/10^6 spermatozoa) of spermatozoa, with exposure to laser during preservation at 37°C in camels

Incubation time (hours)	Time of exposure (min)						Mean±SE
	Control	2	4	6	8	10	
0	45.78±1.47	45.56±1.43	47.11±1.31	47.33±1.43	48.22±1.31	51.22±1.40	47.54^{F}±0.60
1	49.11±1.47	48.89±1.47	49.67±1.59	51.00±1.48	50.89±1.49	53.67±1.46	50.54^{E}±0.62
2	52.67±1.59	52.33±1.59	53.00±1.53	53.78±1.54	54.56±1.61	57.67±1.56	54.00^{D}±0.66
4	57.11±1.95	56.56±1.91	57.22±2.01	58.33±1.97	58.78±1.95	61.78±1.94	58.29^{C}±0.79
6	61.33±1.79	60.78±1.79	61.89±1.65	62.22±1.60	63.11±1.81	66.33±1.84	62.61^{B}±0.73
8	65.67±2.00	65.56±1.95	67.00±1.97	67.56±1.97	68.33±1.98	71.56±2.00	67.61^{A}±0.82
Overall mean	55.28^{bc}±1.16	54.94^{c}±1.15	55.98^{bc}±1.15	56.70^{bc}±1.14	57.31^{b}±1.16	60.37^{a}±1.17	56.76

$^{A-F}$Different superscripts values within a column are significantly different (P<0.05).
$^{a-c}$Different superscripts values within a row are significantly different (P<0.05).

Table 6. Activity of ALT enzyme (U/10^6 spermatozoa) of spermatozoa, with exposure to laser during preservation at 37°C in camels

Incubation time (hours)	Time of exposure (min)						Mean±SE
	Control	2	4	6	8	10	
0	42.56±1.51	42.56±1.51	43.56±1.57	43.89±1.52	44.78±1.49	47.56±1.53	44.15^{F}±0.64
1	46.22±1.53	45.78±1.62	46.44±1.61	47.11±1.73	47.67±1.65	50.67±1.64	47.31^{E}±0.67
2	50.11±1.70	50.00±1.74	50.89±1.76	51.56±1.65	51.89±181	54.89±1.83	51.56^{D}±0.72
4	54.56±1.74	54.33±1.67	55.11±1.64	55.44±1.82	56.33±1.72	59.67±1.72	55.91^{C}±0.71
6	59.78±1.87	59.56±1.84	59.89±1.83	60.89±1.81	61.22±1.86	64.22±2.03	60.92^{B}±0.76
8	64.56±1.72	64.11±5.08	64.78±1.67	65.78±1.71	66.11±1.68	69.67±1.72	65.83^{A}±0.71
Overall mean	52.96^{b}±1.23	52.72^{b}±1.22	53.44^{b}±1.21	54.11^{b}±1.23	54.67^{b}±1.22	57.78^{a}±1.25	54.28

$^{A-F}$ Different superscripts values within a column are significantly different (P<0.05).
$^{a-b}$ Different superscripts values within a row are significantly different (P<0.05).

Table 7. Activity of ALP enzyme (U/10^6 spermatozoa) of spermatozoa, with exposure to laser, during preservation at 37°C in camels

Incubation time (hours)	Time of exposure (min)						Mean±SE
	Control	2	4	6	8	10	
0	21.44±0.94	21.22±0.94	21.89±0.97	23.00±1.05	24.00±1.00	27.33±1.01	23.15^{F}±0.48
1	24.67±0.93	24.22±1.06	25.00±1.09	25.56±1.06	26.44±1.14	29.67±1.31	25.93^{E}±0.49
2	27.33±0.95	27.11±1.02	27.56±1.04	28.00±1.03	28.67±1.09	31.89±1.12	28.43^{D}±0.46
4	30.78±1.17	30.78±1.17	31.56±1.17	32.33±1.15	33.00±1.17	36.22±1.15	32.44^{C}±0.52
6	34.33±1.25	34.22±1.28	35.44±1.33	35.67±1.36	36.22±1.36	39.44±1.37	35.89^{B}±0.56
8	37.67±1.17	37.67±1.17	38.11±1.34	38.67±1.20	39.22±1.16	42.44±1.30	38.96^{A}±0.53
Overall mean	29.37^{c}±0.86	29.20^{c}±0.88	29.93^{bc}±0.90	30.54^{bc}±0.88	31.25^{b}±0.86	34.50^{a}±0.87	30.79

$^{A-F}$ Different superscripts values within a column are significantly different (P<0.05).
$^{a-c}$ Different superscripts values within a row are significantly different (P<0.05).

Sperm penetration into cervical mucus:

The penetrating ability of spermatozoa exposed to various times of exposure to green irradiation (532 nm, three mW) into the cervical mucus of she-camel showed (P<0.05) better with all times of exposure to irradiation than the control during preservation for four hours at 37°C (Fig, 1). The highest score of penetrating ability of spermatozoa into the cervical mucus of she-camel was reported with spermatozoa exposed to irradiation for six min compared to the control group. However, the extension of preservation time at 37°C (P<0.05) decreased the penetrating ability of spermatozoa into the cervical mucus of she-camel with all groups including the control group (non-irradiated group). The highest score of penetrating ability of spermatozoa was recorded at zero time of incubation, while the lowest score of penetrating ability of spermatozoa into cervical mucus was recorded at four hours of incubation for all groups including the control group (Fig, 1).

A similar finding was reported by Aitken *et al.* (1983) who found a positive correlation between the movement of spermatozoa in human and their penetrating ability into the cervical mucus. Alexander (1981) and Murase *et al.* (1990) reported that, the duration of motile spermatozoa and the distance of penetration in the mucus positively correlated to the conception rates. Similar findings were also reported by Zeidan (2002) and El-Mahdy (2019) in the dromedary camels.

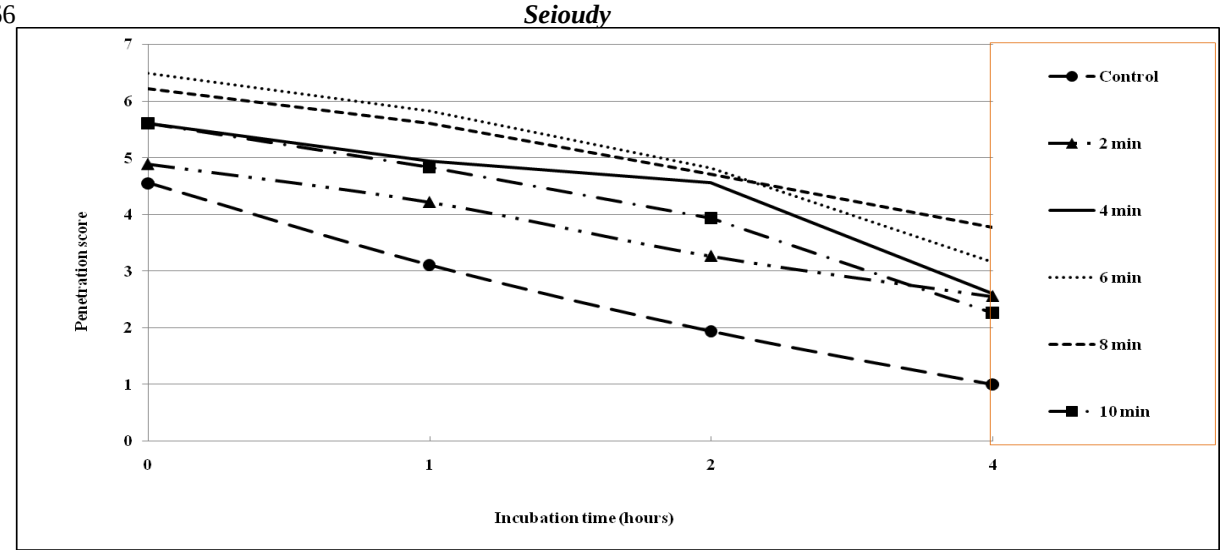

Fig. 1. Penetrating ability of dromedary camel spermatozoa exposed to different times of laser into she-camel cervical mucus during preservation at 37°C.

CONCLUSION

In conclusion, semen parameters were improved by laser radiation which increases camel semen quality making the procedure easy, efficient and cheap for enhancing the artificial insemination. Due to the applicability of this technique and the advantages it brings, it is proposed for epididymal spermatozoa collection and short-term storage for insemination, by exposing to six min of green irradiation in a short-wavelength to enhance the fertility of the dromedary camel.

REFERENCES

Abdalla, E.B., A.E. Zeidan, A.F. Seioudy, F.A. Khalil, Z.A. Abdel-Salam, M.R. Badr and M.W. Allam, 2021. Effect of green laser irradiation on epididymal camel spermatozoa quality stored at 5°C. Arab Univ. J. Agric. Sci., Ain Shams Univ., Cairo, Egypt, 29(1):307-314.

Abd El-Salaam, A.M., G.M. Absy, S.A. Gabr and A.E.B. Zeidan, 2012. Viability, enzaymatic activity and penetrating ability of spermatozoa into she-camel cervical mucous as affected by different extenders. J. Camel Pract. Res., 18(2):1-9.

Ahmed, R., O. Hamdy, S. Elattar and A.A. Soliman, 2024. Improving human sperm motility via red and near-infrared laser irradiation: in-vitro study. Photochem.Photobiol. Sci., 23(2):377-385.

Aitken, R.J., F. Best, D.W. Richardson, R. Sechats and G. Simm, 1983. Influence of caffeine on movement characteristics, fertility capacity and ability to penetrate cervical mucus of human spermatozoa. J. Reprod. Fertil., 67(1):19-27.

Alexander, N.J., 1981. Evaluation of male infertility with an in-vitro cervical mucus penetration test. Fertil. Steril., 36(2):201-208.

Anand, S.R., 1979. Buffalo sperm metabolism: An assessment of motility, live spermcounts and leakage of acrosomal enzymes from buffalo spermatozoa during dilution and preservation. In: Buffalo Reprod. Artif. Insemin. Proc. Seminar FAO/SIAD/Govit. of India. N.D.R.I., Karnal, India, 284-291.

Calderhead, R.G., 1990. On the correct reporting of parameters and consistent use of terminology in reporting clinical and experimental LLLT procedures. Laser Therapy, 3:2-7.

Cohen, N., R. Lubart, S. Rubinstein and H. Breitbart, 1998. Light irradiation of mouse spermatozoa: Stimulation of in vitro fertilization and calcium signals. J. Photochem. Photobiol. B, 68(3):407-413.

Corral-Baque´s, M.I., M.M. Rivera, T. Rigau, J.E. Rodriguez-Gil and J. Rigau, 2009. The effect of low-level laser irradiation on dog spermatozoa motility is dependent on laser output power. Lasers Med. Sci., 24(5):703-713.

Duncan, D.B., 1955. Multiple range and multiple F-test. Biometrics, 11:1-42.

El-Hassanein, E.E., K.A. El-Bahrawy, A.Z. Fateh El-Bab and M.M. Zeitoun, 2004. Sexual behavior and semen physical traits of desert male camels in rut. J. Egypt. Vet. Med. Assoc., 64 (4): 305-321.

El-Mahdy, A.M.M., 2019. Some genetic and non-genetic factors affecting blood parameters and relationship with performance in camels. M.Sc. Thesis, Fac. Agric., Zagazig Univ., Zagazig, Egypt.

Eskin, B.A., S. Azarbel, R. Sepic and W.G. Slate, 1973. *In vitro* responses of the spermatozoa-cervical mucus system treated with prostaglandin (F2α). J. Obst. Gynecol., 41 (3): 436-439.

Goldstein, S.F., 1969. Irradiation of sperm tails by laser microbeam. J. Exp. Biol., 51(2):431-441.

Goto, K., Y. Kajihara, M. Koba, S. Kosaka, Y. Nakamishi and K. Ogawa, 1989. In-vitro fertilization and development of in-vitro matured bovine follicular oocytes. J. Anim. Sci., 67(8):2181-2185.

Hackett, A.J., and J.W. Macpherson, 1965. Some staining procedures for spermatozoa. Can. Vet. J., 6(3):55-62.

Hanson, E.W., I.W. Overstreet and D.F. Katza, 1982. A study of the relationship of motile sperm numbers in cervical mucus 48 hours after artificial insemination with subsequent fertility. American J. Obst. Gynecol., 143(1):85-90.

Iaffaldano, N., G. Paventi, R. Pizzuto, M. Dilorio, J.L. Bailey and A. Manchisi, 2016. Helium-neon laser irradiation of cryopreserved ram sperm enhances cytochrome C oxidase activity and ATP levels improving semen quality. Theriogenology, 86(3):778-784.

Iaffaldano, N., M.P. Rosato, G. Paventi, R. Pizzuto, M. Gambacorta and A. Manchisi, 2010. The irradiation of rabbit sperm cells with He-Ne laser prevents their in vitro liquid storage dependent damage. Anim. Reprod. Sci., 119(1-2):123-129.

Karu, T.I., 2012. Lasers in infertility treatment: Irradiation of oocytes and spermatozoa. Photomed. Laser Surg., 30(5):239-241.

Lone, S.A., T.K. Mohanty, A. Kumaresan and M. Bhakat, 2018. Laser irradiation effects and its possible mechanisms of action on spermatozoa functions in domestic animals. Asian Pac. J. Reprod., 6(3):97-103.

Murase, T., K. Okuda and K. Sato, 1990. Assessment of bull fertility using a mucus penetration test and a human chorionic gonadotropin stimulation test. Theriogenology, 34(5):801-812.

Musa, B., H. Sieme, H. Merkt and B.E.D. Hego, 1992. Artificial insemination in dromedary camels. Proc. 1st Intern. Camel Conf. UK, Newmarket, 179-182.

Nicolae, D., Z. Stela, A.A. Hortanse, T. Irina, N. Iaffaldano, G. Paventi and C. Dragomir, 2015. Study on the effects of exposure to different doses of energy generated by a He-Ne laser on the quality of frozen-thawed semen of ram. Rom. Biotech. Lett. M., 20(3):10381-10387.

Pareek, C., U. Gajbe, P.A. Bawaskar, G.R. Bandre and A.K. Badge, 2023. Laser-guided sperm selection: Optimizing the reproductive success rate in assisted reproductive technology. Cureus, 15(11):1-7. e49052. DOI 10.7759/cureus.49052.

Reitman, S., and M. Frankle, 1957. A colorimetric method for determination of serum oxaloactic and glutamic pyruvic transaminase. Anim. Clin. Pathol. J., 28(1):56-63.

Salisbury, G.W., N.L. Van Demark and J.R. Lodge, 1978. Physiology of Reproduction and Artificial Insemination of Cattle. W.H. Freeman and Company, San Francisco, USA.

SAS., 2000. SAS User's Guide. Statistical Analysis System Institute Inc., Cary, NC.

Tibary, A., and A. Anouassi, 1997. Male Breeding Soundness Examination. Theriogenology in Camelidae, 1st Edition, Ministry of Agriculture and Information, UAE., 79-114.

Watson, P.F., 1975. Use of a giemsa stain to detect changes in acrosomes of frozen ram spermatozoa. Vet. Rec., 97(1):12-15.

Yeste, M., F. Codony, E. Estrada, M. Lleonart, S. Balasch and A. Peña, 2016. Specific LED-based red light photo-stimulation procedures improve overall sperm function and reproductive performance of boar ejaculates. Sci. Rep., 6(1):22569.

Zan-Bar, T., B. Bartoov, R. Segal, R. Yehuda, R. Lavi and R. Lubart, 2005. Influence of visible light and ultraviolet irradiation on motility and fertility of mammalian and fish sperm. Photomed. Laser Surg., 23(6):549-555.

Zeidan, A.E.B., 2002. Semen quality, enzymatic activities and penetrating ability of spermatozoa into she- camel cervical mucous as affected by caffeine addition. J. Camel Pract. Res., 9(2):153-161.

التغيرات في الحيوانات المنوية البربخية للإبل نتيجة التشعيع بالليزر الأخضر

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أُجريت هذه الدراسة على عدد ٢٠من الإبل السوداني مع عدد إجمالى ٤٠ خصية. هدفت هذه الدراسة إلى تحديد تأثير التشعيع بالليزر الأخضر ذو الموجات القصيرة الطول الموجى عند فترات زمنية مختلفة تراوحت بين صفر وعشر دقائق على جودة الحيوانات المنوية البربخية فى الإبل. بعد التعرض لليزر، تم تحديد نسبة كلاً من الحيوانات المنوية المتحركة والحية وتلف الأكروسوم للحيوانات المنوية ونشاط إنزيمات AST وALT وALP، وذلك عند التحضين على درجة حرارة ٣٧ درجة مئوية لمدة ٨ ساعات. كما تم فحص قدرة الحيوانات المنوية المعرضة لأشعة الليزر عند فترات زمنية مختلفة على إختراق مخاط عنق الرحم للناقة عند درجة حرارة ٣٧ درجة مئوية لمدة ٤ ساعات. أظهرت النتائج أن التعرض لأشعة الليزر لمدة ٦ دقائق حقق أعلى نسبة للحيوانات المنوية المتحركة. بينما حقق التعرض لمدة دقيقتين أقل نسب للحيوانات المنوية الميتة، وتلف الأكروسوم، وإنزيمات AST وALT وALP. أدى زيادة وقت التحضين إلى إنخفاض($P<0.05$) نسبة الحيوانات المنوية المتحركة. في الوقت نفسه، زادت نسب الحيوانات المنوية الميتة وتلف الأكروسوم وإنزيمات AST وALT وALP. كانت قدرة الحيوانات المنوية على إختراق مخاط عنق الرحم أفضل ($P<0.05$) في جميع المجموعات مقارنةً بمجموعة المقارنة أثناء التحضين. في الختام، يمكن إعتبار التشعيع بالليزر تقنية رخيصة الثمن وفعالة لتحسين جودة السائل المنوي للإبل من خلال زيادة نسب الحيوانات المنوية المتحركة، وقابليتها للحياة، وسلامة الأكروسوم، والتي يمكن إستخدامها كمؤشر لتعزيز وظيفة الميتوكوندريا لإطالة بقاء الحيوانات المنوية.