Plant Archives Vol. 20, Supplement 2, 2020 pp. 1830-1833 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

EFFECT OF ELECTROMAGNETIC WAVES EMITTED FROM CELLULAR PHONE ON SOME DILUTED SEMEN CHARACTERISTICS OF AWASSI RAM *IN VITRO*

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Abstract

The objective of this experiment was designed to examine the effect of electromagnetic waves (EMW) emitted from cell phones on diluted semen characteristics of Awassi ram *in vitro*. We hypothesized that ram diluted semen characteristics would be decreased following exposure to EMW emitted from cell phones. Semen was collected from an Awassi Ram seven times. Each time, two ejaculates were pooled and extended (1:10) in egg-yolk extender, then randomly divided into two groups Control (C) and Treatment (T) with replicate for each group. Each group was kept in a separate water path at 37ºC. The treatment group was exposed to EMW by placing a cell phone device (Nokia X1) in talk mode, 10 cm distance from semen samples. However, the control group was kept in a separate water bath, in a different room, without exposing to EMW. Sperm mass activity (%), individual motility (%), dead sperm, and abnormal sperm were estimated after (0, 1, 2, 3, and 4 hours) following continuous exposure to EMW. The mass activity and individual motility were significantly decreased in the treatment group compared to the control group three hours of exposure to EMW. In addition, the percentage of dead sperm and abnormal sperms were increased in the treatment group compared to the control group three hours post-exposure. The results showed significant differences in EMW on the characteristics of Awassi ram semen. In conclusion, the EMW emitted from the cell phone during talk mode may negatively affect the sheep semen characteristics by increasing the free radicals to end up with oxidative stress and increase the life cell temperature.

***Keywords*:** Cellular phone, Awassi ram, diluted Semen, Electromagnetic waves

Introduction

In our modern life, it becomes clear the race towards the use of innovative technology such as the internet, email, social media, and smart cellular phones (Agarwal, Singh, Hamada, & Kesari, 2011). Between 2015 and 2020, mobile–cellular subscription registered continuous double-digit growth in the world to reach 4.68 billion (Statista, 2016). The number of cell phone subscribers increased by more than 600 million, almost all of them in China, India, and the United States to be around 5 billion. The cell phone devices contain unites for sending and receiving radio signals by electromagnetic waves (EMW). These waves usually limited between (900-1800 GHz), which contains much less energy than those that cause ionizing atoms and molecules (Zamanian & Hardiman, 2005). However, the use of cell phones increased global interest in the risk of these waves on body and health (Ng, 2003). Despite more than a decade of research in this field, the potentially harmful effects of cell phone radiation remain controversial (Agarwal *et al*., 2011). It was found damaged in DNA (Lai & Singh, 1996), brain tumors (Khurana, Teo, Kundi, Hardell, & Carlberg, 2009), hypertension (Braune, Wrocklage, Raczek, Gailus, & Lücking, 1998), decrease melatonin level (Burch, Reif, Yost, Keefe, & Pitrat, 1998), sleep disorders (Huber *et al*., 2000), difficulty concentration, fatigue, and headache (Oftedal, Wilén, Sandström, & Mild, 2000). Previous studies on the effect of the EMW emitted from cell phones showed either no effect (Ozguner *et al*., 2005) or with effect (Dasdag *et al*., 1999) on semen viability. In humans, the use of cell phones during talk mode resulted in reduce sperm viability (Agarwal *et al*., 2009). Previous research on cooled ram semen has found that the EMW did not affect negatively on semen characteristics (Mahdi & Hassan, 2012). Although the effect of cell phone EMW has a negative impact on human semen *in vitro*, we do not know what the effect of EMW on sheep semen *in vitro*. Therefore, we conducted this study to examine the effect of EMV emitted from cell phones on some Awassi ram semen characteristics *invitro*.

Materials and Methods

This experiment was conducted in the Department of Animal Production, College of Agriculture, Al-Qasim Green University. Semen was collected from an Awassi ram aged 3.5 years old and weight 35 Kg by artificial vagina for seven weeks, one ejaculate/week. Samples were, immediately, diluted by Tris–egg yolk (1:10), then distributed randomly into two groups: control group (C) and treatment group (T). All semen samples were kept in two different water paths at 37 ºC, the first water path contained the control group, and the second one contained the treatment group. The treatment group was exposed to EMW by placing a cell phone device (Nokia X1) in talk mode, 10 cm distance from all semen treatment samples. Mass activity and individual motility were estimated (0-100) according to the method described by (Walton A., 1933). The percentage of dead sperm and sperm abnormalities (head, mid-piece, and tail) were evaluated by using Eosin–Nigrosine stain as described by (Swanson & Bearden, 1951). All semen groups were evaluated at the time (0) prior to exposure and then at (1, 2, 3, and 4 hours) following continuous exposure to EMW. For more accurate, the experiment was repeated seven times, two replicates for the control and treatment group.

Statistical analysis

Data were reported as mean ± standard error (SEM) for all parameters. Statistical analysis was conducted by using the general leaner model by using the SAS program (SAS, 2012). The comparative between means was conducted by using Duncan's Multiple Range Test (Duncan, 1955) to examine the effect of treatment, time, and interaction on semen characteristics *in vitro*.

Results and Discussion

In this study, the results showed a significant effect of the electromagnetic waves emitted from cellular phones on the characteristics of Awassi ram semen in all parameters *in vitro*. The mass activity significantly differed between treatment, time, and interaction between treatment and time ($p< 0.0001$, $p< 0.0001$, and $p< 0.001$), respectively (Figure 1). Also, individual motility (%) significantly differed by treatment, time, and interaction between treatment and control group ($p< 0.0001$, $p< 0.0001$, and $p< 0.0004$), respectively (Figure 2). This finding was supported by (Kilgallon and Simmons 2005; Mailankot *et al*., 2009; Gevrek *et al*., 2017) how reported that the mobility of the sperm was affected by prolonged cell phone usage. However, (Mahdi & Hassan, 2012) did not find a significant decrease in cell phone usage on diluted ram semen mobility. It is important to mention that in Mahdi's study, the diluted ram semen was cooled to 4 ºC.

On the other hand, dead sperms were significantly increased by treatment ($p<0.0001$), time ($p<0.0001$), and interaction between treatment and time ($p<0.0004$) compared to the control group (Figure 3). This result was supported by (Yan *et al*., 2007), who reported that the EMW emitted from the cell phone increased the dead sperms in rats. However, (Mahdi & Hassan, 2012) did not find a significant effect of cell phones on the abnormal sperms exposed to EMW emitted from cell phones. Also, abnormal sperms were significantly increased by treatment ($p<0.003$), Time ($p<0.0001$), and interaction between treatment and time ($p<0.006$) compared to the control group (Figure 4). This result was supported by (Wdowiak *et al*. 2007) how found that the abnormal sperms increased with prolonged use of cell phones in humans. Also, (Adams, Galloway, Mondal, Esteves, & Mathews, 2014) concluded that sperm viability reduced with prolonged cell phone usage. However, (Mahdi & Hassan, 2012) did not find a significant effect of cell phones on the abnormal sperms exposed to EMW emitted from cell phones. It is important to mention that all parameters were affected negatively three hours following cell phone exposure.

Although the effect of cell phone usage on ram semen was not clearly reported, it might be related to the effect of duration of cell phone usage. The prolonged exposure to EMW emitted from the cell phones decreases the viability of the semen, which might be related to oxidative stress or heat effect. The free radicals produced in the semen caused oxidative stress, which leads to a decrease in the semen quality (La Vignera *et al*., 2012). Anti-oxidant additive to the semen reduced the EMW activity in the rat (Gevrek *et al*., 2017). In addition to that, prolonged exposure to EMW might be related to the increase in thermal activity. The type of radiation emitted from the cell phone is radio frequency, which causes rapid increases in the temperature of the living cells (Challis, 2005) and reduces sperm quality. Cooling the diluted semen to 4 ºC resulting in decreased the thermal activity of EMW (Mahdi & Hassan, 2012).

In conclusion, the EMW influenced the characteristics of diluted Awassi ram semen by significantly decrease the percentage of mass and individual motility after three hours. In addition to significantly increase the dead and abnormal sperms following prolonged exposure to EMW emitted form the cell phone. More investigation needed to evaluate the EMW released from the cell phone on other parameters such as DNA damages and free radicals' indicators.

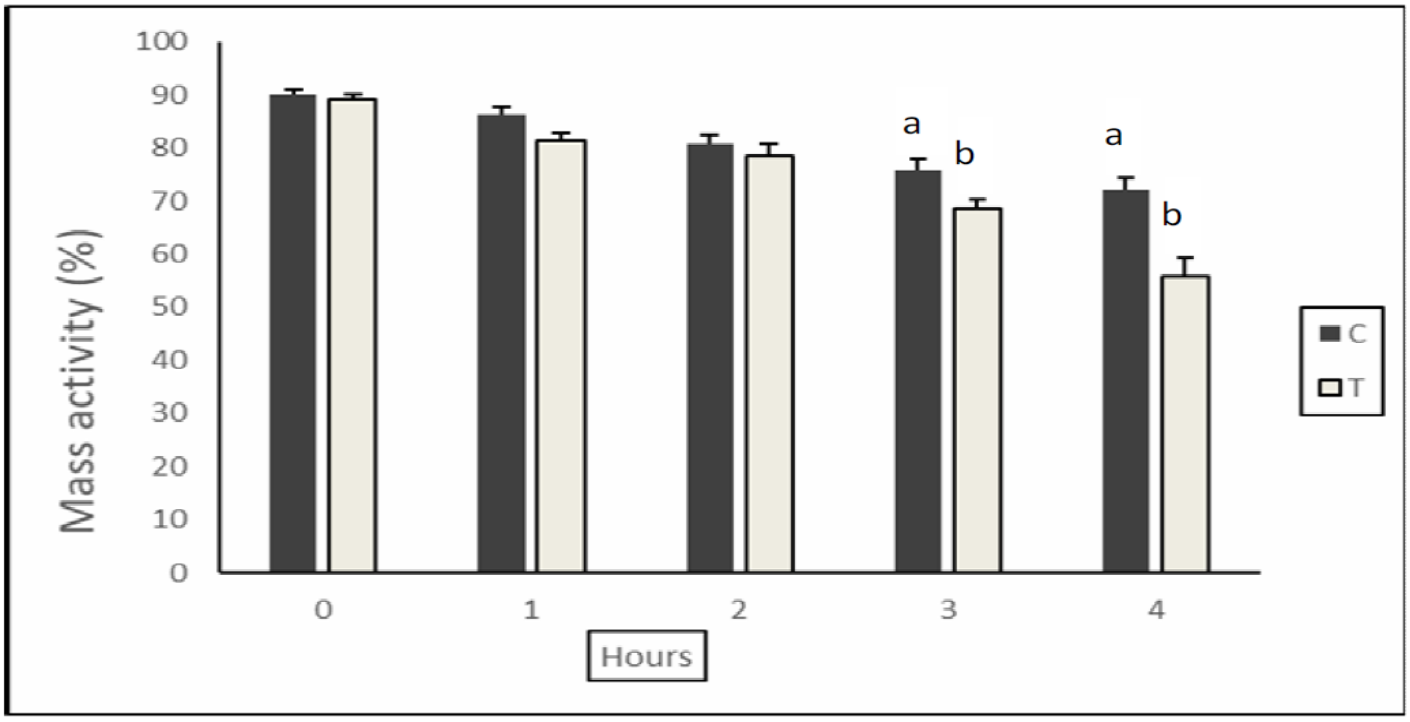

Fig. 1: Effect of cell phone electromagnetic waves (EMW) exposed on mean (± SEM) mass activity on Awassi ram semen. Semen were evaluated immediately before EMW exposure (0 hr) and after (1, 2, 3, and 4 hr) in treated (T) and control group (C). [ab] Values with different superscripts are significantly different ($p<0.0001$)

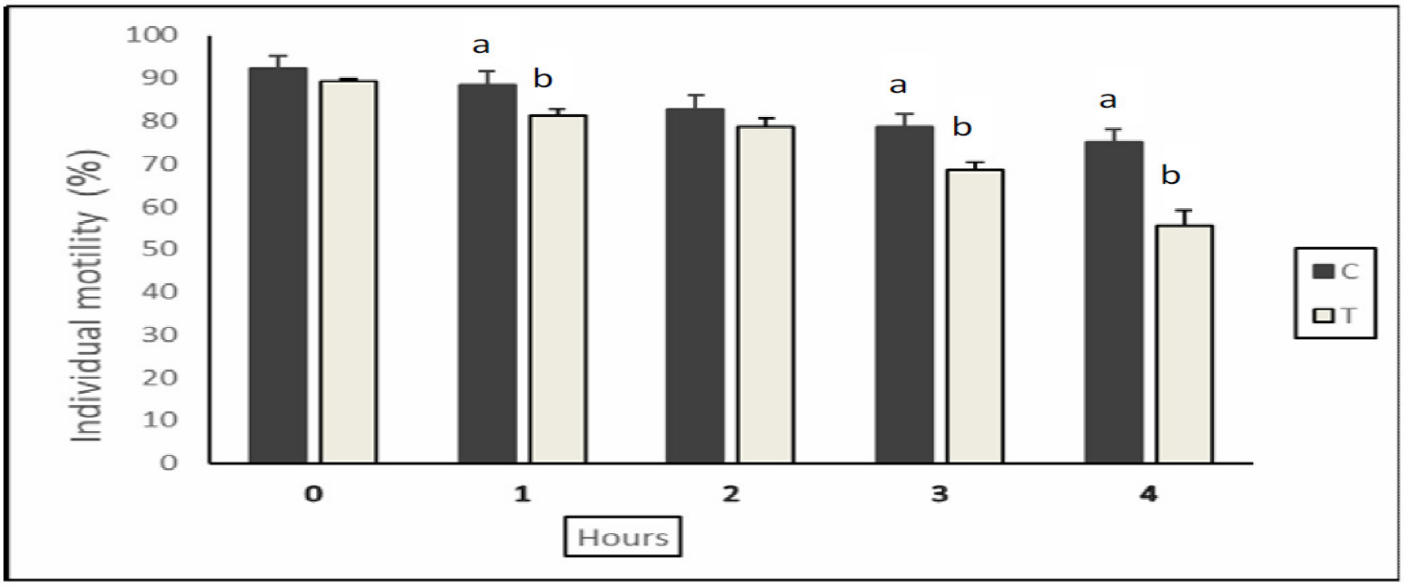

Fig. 2: Effect of cell phone electromagnetic waves exposed on mean (± SEM) individual motility on Awassi ram semen. Semen were evaluated immediately before EMW exposure (0 hr) and after (1, 2, 3, and 4 hr) in treated (T) and control group (C). ab Values with different superscripts are significantly different ($p<0.0001$)

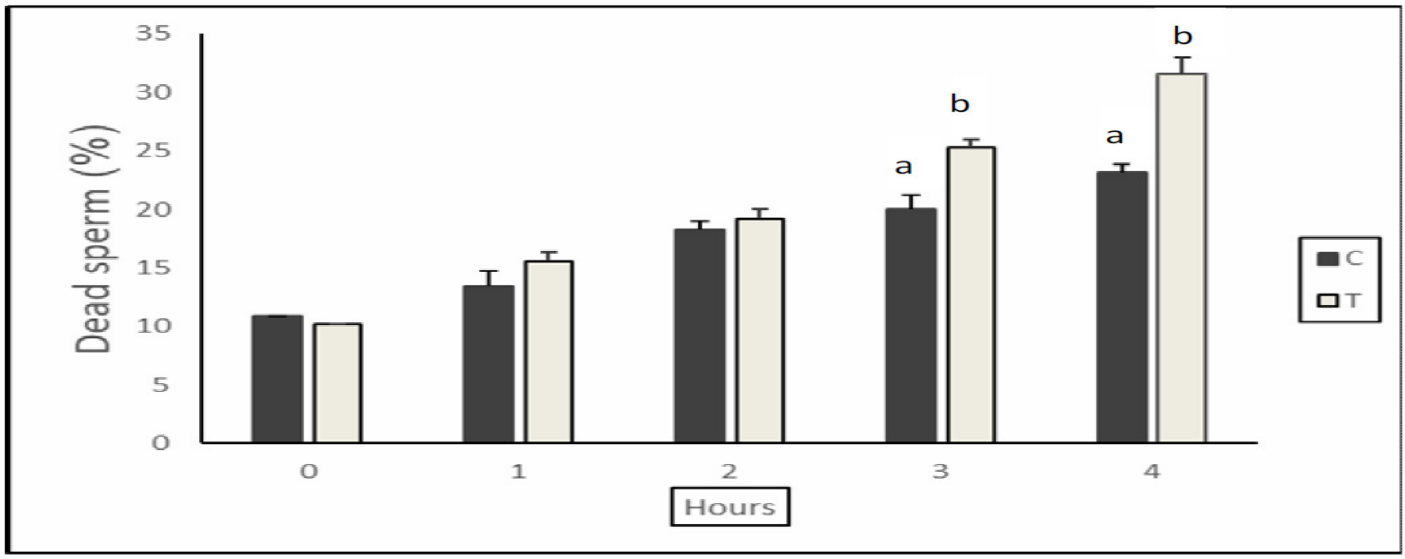

Fig. 3 : Effect of cell phone electromagnetic waves exposed on mean (± SEM) dead sperm on Awassi ram semen. Semen were evaluated immediately before EMW exposure (0 hr) and after (1, 2, 3, and 4 hr) in treated (T) and control group (C). ab Values with different superscripts are significantly different ($p<0.0001$).

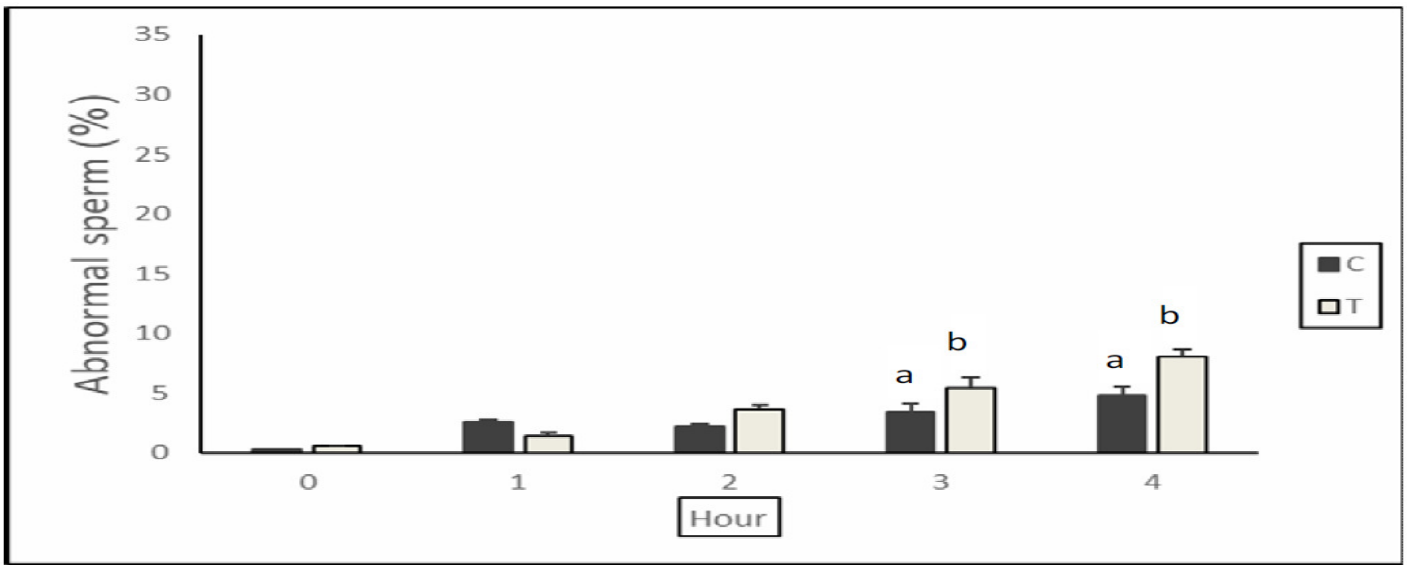

Fig. 4: Effect of cell phone electromagnetic waves exposed on mean (± SEM) abnormal sperm on Awassi ram semen. Semen were evaluated immediately before EMW exposure (0 hr) and after (1, 2, 3, and 4 hr) in treated (T) and control group (C). ab Values with different superscripts are significantly different ($p<0.0001$)

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