ARTICLE / INVESTIGACIÓN

The Role of CoQ10 and Selenium in Some Physiological Variables in Rabbits Under Oxidative Stress

Muntaha Mahmoud Al-Kattan*, Amina Jasim Alhayani

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[1] Department of Biology, College of Science, Mosul University, Mosul, Iraq.
[2] BDepartment of Medical Laboratory Technologies/ Al Noor University College, Mosul, Iraq.
Corresponding author: muntsbio17@uomosul.edu.iq.

Abstract: The current study was designed to investigate whether the use of coenzyme Q10 at a concentration of 200 mg/kg body weight and selenium at a concentration of 0.05 mg/kg improve the physiological and biochemical characteristics and reduce the adverse effects of H2O2 in domestic rabbits, Twenty local male rabbits, their ages ranged from (1 ±1.5) years. Their weights were (1500 ± 1700) grams. They were randomly Enrolled into four animals each, as follows: The first group was a control group, which was given a standard diet and regular water; for the second, third and fourth groups, they were given H2O2 at a concentration of 0.5%, coenzyme Q10 at a concentration of 200 mg/kg body weight, and sodium selenite at a concentration of 0.05 mg/kg, respectively, for 4 weeks. The results of the Current study showed that there was a significant increase in the concentration of male sex hormones Spermatogenic Stimulating Hormone (SSH), Interstitial Cell Stimulating Hormone (ICSH), as well as Testosterone, accompanied by an increase in the concentration of Glutathione (GSH) and a decrease in the concentration of Malondialdehyde (MDA) for the third and fourth groups compared with the control group at the probability level (P≤0.05). The second group showed a significant decrease in the concentration of male sex hormones (SSH), (ICSH) and Testosterone, accompanied by a decrease in the concentration of Glutathione and a significant increase in the concentration of Malondialdehyde compared with the control group and the rest of the groups.

Key words: Coenzyme Q10, Selenium, Males hormones, Oxidative Stress.

Introduction

Domesticated rabbits are notable for their high reproductive capacity, fast growth, and short gestation periods compared to other domesticated animals[1]. If raised well in healthy conditions, rabbits are raised in typical farms that generate huge profits. They are a continuous source of income for farmers to improve the standard of living, and they do not need large areas in breeding if compared to the rest of the other animals[2], and they are playing an ever-increasingly significant part in the production of meat in every region of the planet[3]. The imbalance between the production of free radicals and the ability of the body's defense system of antioxidants to detoxify or weaken oxidative damage to the DNA of proteins and fats is known as oxidative stress[4]. Antioxidants are the most important means of preventing oxidative stress. Oxidative stress is one of the most critical issues affecting the growth and production of animals. The various processes essential to life in the body will produce radicals; hence, these radicals serve as a defensive mechanism against the potentially damaging effects of free radicals[5]. Coenzyme Q10 is one of the essential antioxidants known as ubiquinone, naturally found in higher and microorganisms. It is a fat-soluble antioxidant and the only one that can be synthesized inside the body. Ubiquinone is naturally found in higher and microorganisms. Coenzyme Q10 is naturally found in higher and microorganisms[6]. An outstanding part will be played in energy production By one of the electron and proton transport compounds in the electron transport chain that occurs in the mitochondria[7] and protects cell membranes from lipid peroxidation, as well as its role in determining other antioxidants such as vitamin E and C[8].

Coenzyme Q10 has a unique structure, which gives it distinct properties and an apparent effect in physiological conditions. It is an essential cofactor for energy production, adenosine triphosphate (ATP), and has high antioxidant properties. It is an electron-transporting compound in oxidative phosphorylation in the mitochondria of cells[9]. Through its properties as an antioxidant, it works to restore the effective forms of work as an antioxidant for both vitamin E and C, as it reduces the inactive form, which is in the form of α-Tocopheryl radical resulting from the reaction with fats or in the form of an oxygen radical converting it into the active form α-Tocophero[10]. Thakur and colleagues found that increasing the concentration of Coenzyme Q10 in seminal plasma improved total TAC capacity and positively affected sperm concentration, motility, and normal morphology[11]. Selenium is one of the essential microelements, and it is a robust biological mineral[12] and has several important physiological roles in many organisms[13]; selenium is considered one of the essential and highly efficient antioxidants that helps protect rabbits from oxidation of fats and proteins[14]. Also, selenium plays a significant role in increasing the antioxidant enzyme Gpx[15].

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Materials and methods

The field of the study Time and Place

The present study has been conducted in Laboratories of the College of Sciences, Department of Biology, University of Mosul.

Materials used in the study

Animals under study

After ensuring that the rabbits were healthy, the 20 male local rabbits used in this research were confined in metal cages with dimensions of 60×40×50 cm in length, width and height, respectively, that had been purpose-built for this investigation. The rabbits' weights ranged from (1500 ± 1700) grams, and ages ranged from (1 ±1.5) years, and they were purchased from nearby markets. They were provided with a standard diet for rabbits with a protein content of 16.5%, and the National Research Council[16] confirmed this percentage; the collective feeding lasted for a whole month. The appropriate conditions included temperatures ranging from (25-28) °C, lighting for approximately 14 hours, and adequate ventilation. The lighting lasted approximately 14 hours. The rabbits were subjected to a preparatory period of one week to acclimatize to the place and the diet before starting the experiment.

Experimental design

In this study, 20 male local rabbits were used, which were distributed into four groups 5 rabbits for each group, and the groups are as follows:

The control group: The rabbits were reared on Which diet and regular water.

The second group was given a Dose of H_2O_2 at a concentration of 0.5% with normal water and a standard diet.

The third group: Rabbits of this group were given COQ10 at a concentration of 200 mg/kg body with a standard diet and regular water.

Fourth group: The rabbits of this group were given a sodium selenate Dose of 0.05 mg/kg with a standard diet and regular water.

Sample collection

After the end of the treatment period, blood samples were obtained from rabbits by drawing blood from the heart directly with a heart stab. The blood was placed in tubes with tight, dry covers free of any anticoagulant and left at room temperature for 20 minutes to obtain the blood serum; the blood serum was kept freezing at -20 °C until hormonal and biochemical tests were performed.

Hormonal Evaluation

Each Spermatogenic Stimulating Hormone (SSH), Interstitial Cell Stimulating hormone (ICSH), and Testosterone were measured in the blood serum using the Accubind ELISA Microwells Analysis Kit, which was supplied by the American Monobind Inc. and using the German company that manufactured the semi-automated ELISA shaker-reader. This examination was based on the principle of Direct Sandwich at a wavelength of 450 nm[17], and the final results were obtained through the values of the standard.

Biochemical examinations

The concentration of Glutathione will be determined in the blood serum

The modified method[17] was used to determine the concentration of Glutathione in the serum. The concentration of Glutathione in the blood serum was calculated based on the following equation:

$$\text{Glutathione Conc. (mmol/l)} = \frac{A}{E \times L} \times 10^6$$

In the blood serum, the concentration of Malondialdehyde will be determined

The concentration of MDA in blood has been determined as one of the essential products of the peroxidation lipid[18]. The concentration of Malondialdehyde was calculated based on the following relationship:

$$\text{MDA Conc.} = \frac{A}{E \times L} \times D$$

Statistical analysis

Results were statistically analyzed according to the simple process experiments system complete random design and used the Duncan multiple range test to find differences between the groups. The results are considered significant at the probability level (P≤0.05), using the statistical program SAS and Covariance test to extract way LSD[19].

Results

The results of this study indicated a significant increase in Spermatogenic Stimulating Hormone (SSH) in two groups treated with Coenzyme Q10 at a concentration of 200 mg/kg body weight and sodium selenate at a concentration of 0.05 mg/kg compared with the control group, as the mean of them reached 2.38 IU/ml and 2.38 IU/ml respectively, noting that there was no significant difference between the two groups. The rabbits exposed to oxidative stress induced using H_2O_2 at a concentration of 0.5% showed a significant decrease at the same probability level as the control group, as its mean was 0.88 IU/ml. Note that the mean of the control group is 1.74 IU/ml.

The values are expressed as the arithmetic mean (±) standard deviation and the number of rabbits/group = 5.

The different letters mean a significant difference at the level (P≤0.05).

Also significant increase in the concentration of Interstitial Cell Stimulating Hormone (ICSH) at P≤0.05 (Figure 2) in the two groups of rabbits treated with Coenzyme Q10 at a concentration of 200 mg/kg body weight and the group treated with a concentration of 0.05 mg/kg of sodium selenate compared with the control group, the mean of them reached 6.38 IU/ml and 6.37 IU/ml respectively, noting that there was no significant difference between the two groups. The group of rabbits exposed to oxidative stress induced by 0.5% of H2O2 showed a significant decrease at the same level of probability compared with the control group, as its mean was 3.25 IU/ml, knowing that the arithmetic mean of the control group was 5.79 IU/ml.

The values are expressed as the arithmetic mean (±) standard deviation and the number of rabbits/group = 5.

The different letters mean that no significant difference can be observed at the level (P≤0.05).

Also, a significant increase in the concentration of Tes-

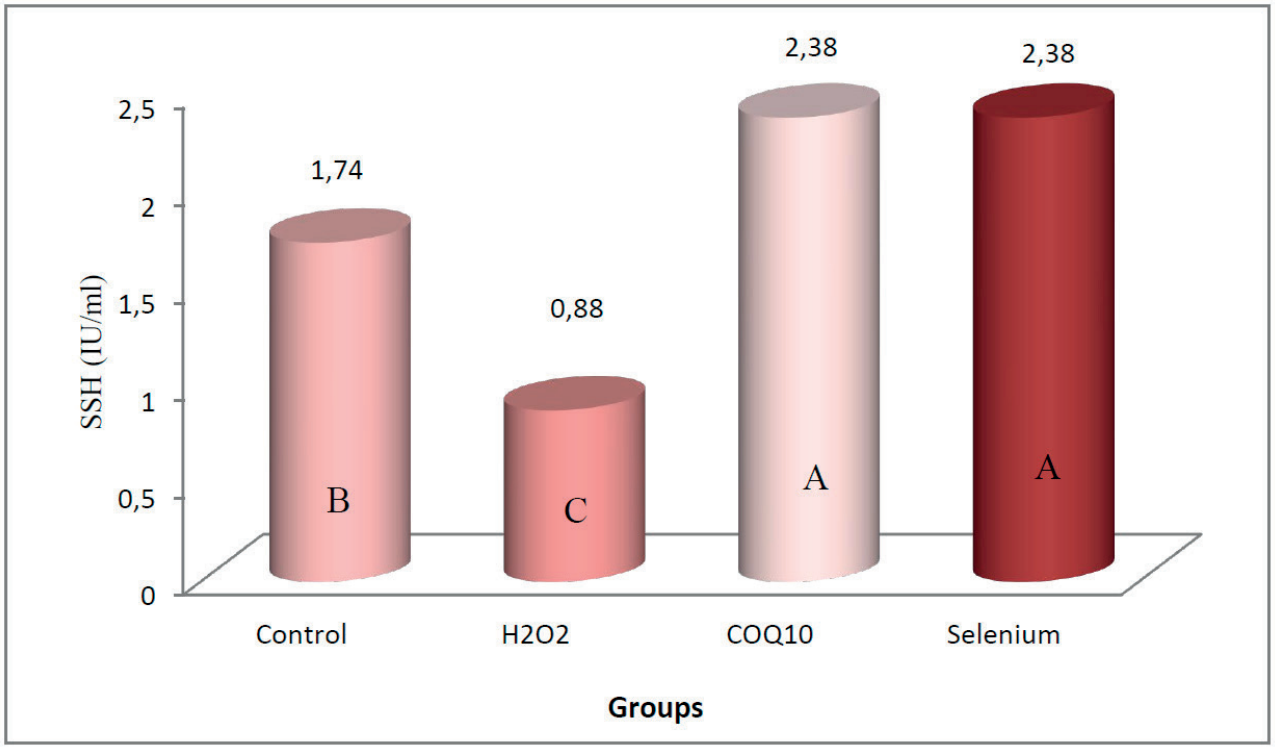

Figure 1. Shows the effect of coenzyme Q10 and sodium selenate on the concentration of Spermatogenic Stimulating Hormone (IU/ml) in rabbits exposed to oxidative stress.

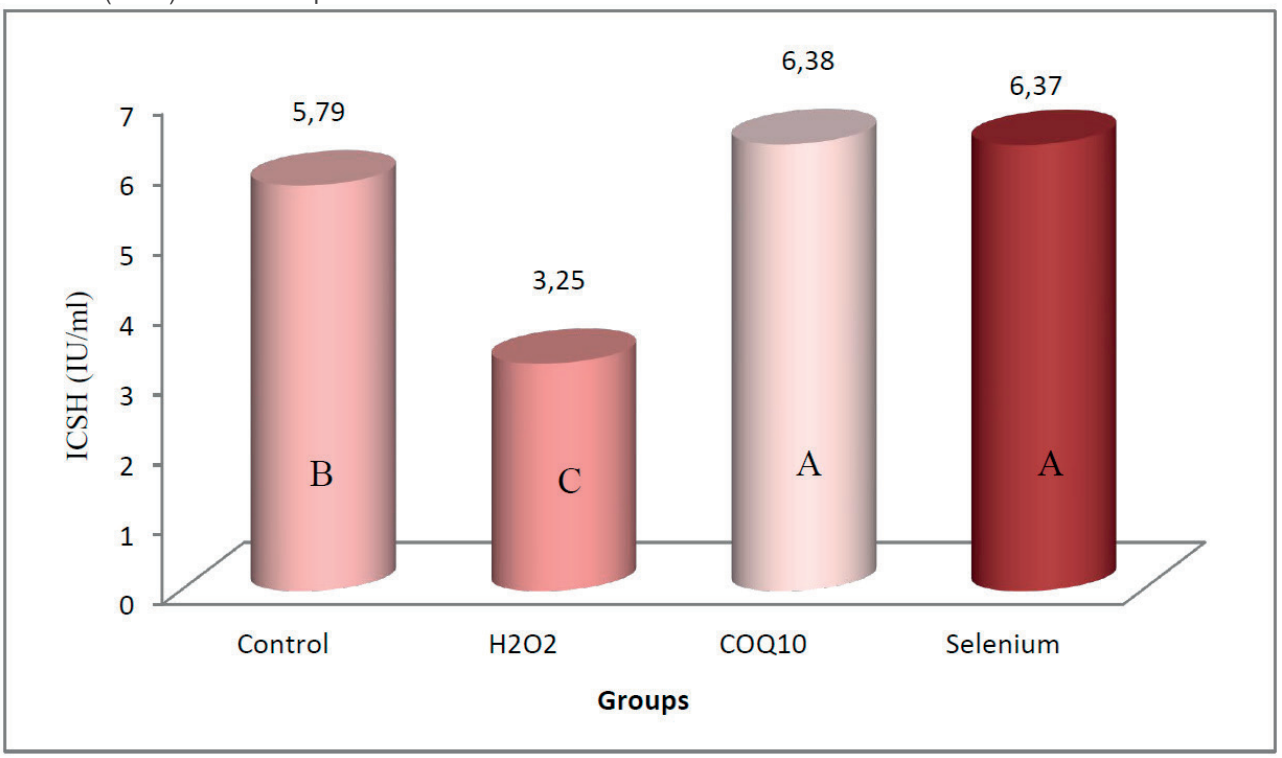

Figure 2. The effect is obvious coenzyme Q10 and sodium selenate on the concentration of Interstitial Cell Stimulating Hormone (IU/ml) in rabbits exposed to oxidative stress.

tosterone hormone at P≤0.05 (Figure 3) in the two groups of rabbits treated with Coenzyme Q10 at a concentration of 200 mg/kg body weight and the group treated with a concentration of 0.05 mg/kg of sodium selenate compared with the control group, where the mean was 4.52 ng/ml and 4.39 ng/ml, respectively, noting that there was no significant difference between the two groups. In contrast, the group of rabbits exposed to oxidative stress induced by using 0.5% of H_2O_2 showed a significant decrease in the concentration of the hormone at the same level of probability compared with the control group, as its mean was 1.70 ng/ml, knowing that the arithmetic mean of the control group was 2.65 ng/ml.

The values can be expressed as the arithmetic mean (±) standard deviation and the number of rabbits/group = 5.

The different letters mean a significant difference at the level (P≤0.05).

Figure (4) showed a significant increase in the concentration of Glutathione (GSH) in the blood serum of local male rabbits at the probability level (P≤0.05) in the two groups of rabbits treated with Coenzyme Q10 at a concentration of 200 mg/kg body weight and sodium selenate at a concentration of 0.05 mg/kg compared with the control group, the mean was 4.60 µmol/L and 4.52 µmol/L, respectively, with no significant difference between them. At the same time, the group of rabbits exposed to oxidative stress induced by using 0.5% of H_2O_2 showed a significant decrease in the concentration of Glutathione at the same level of probability compared with the control group, which gave an arithmetic mean of 1.90 µmol/L. Note that the mean of the control group is 3.30 µmol/L.

The values Were expressed as the arithmetic mean (±) standard deviation and the number of rabbits/group = 5.

The different letters mean to indicate that there is a fundamental difference at this level.

Figure (5) showed a significant decrease in the concentration of Malondialdehyde (MDA) in the blood serum

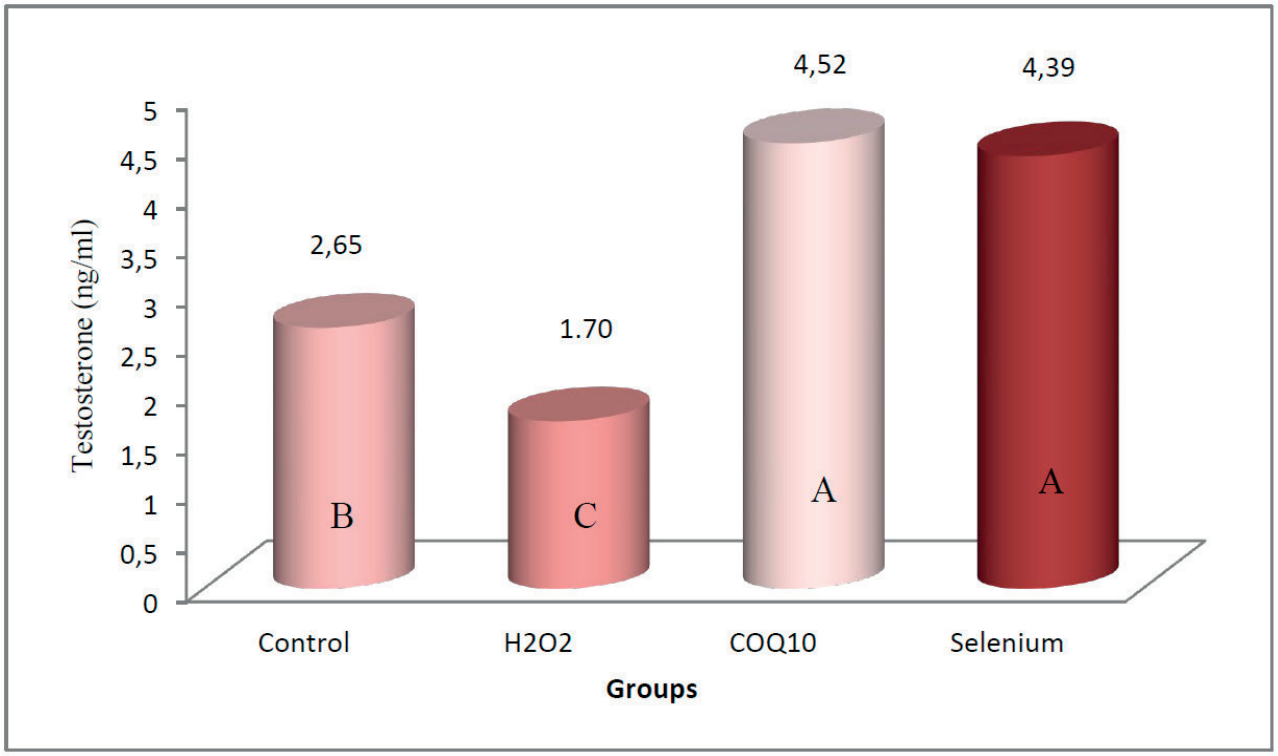

Figure 3. Shows the effect of coenzyme Q10 and sodium selenate on Testosterone concentration (ng/ml) in rabbits exposed to oxidative stress.

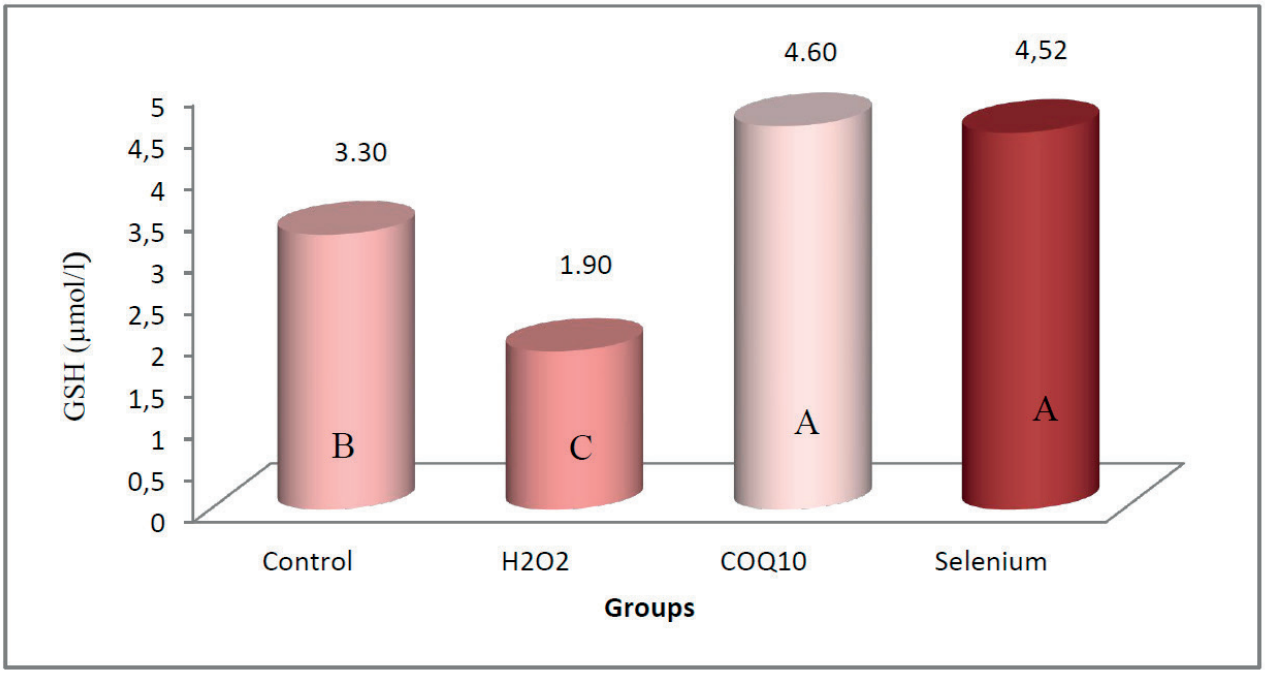

Figure 4. Shows the effect of coenzyme Q10 and sodium selenate on the concentration of Glutathione (ng/ml) in rabbits exposed to oxidative stress.

of local male rabbits at the probability level (P≤0.05) in the two groups of rabbits treated with Coenzyme Q10 at a concentration of 200 mg/kg body weight and sodium selenate at a concentration of 0.05 mg/kg compared to the control group. The decrease was more significant in the group treated with Coenzyme Q10, whose mean was 312.37 nmol/gm, while the group treated with sodium selenate gave a mean of 336.12 nmol/gm. In contrast, the group of rabbits exposed to oxidative stress induced by using 0.5% H_2O_2 showed a significant increase in the concentration of MDA compared with the control group, as its mean was 665.63 nmol/g. Note that the arithmetic mean of the control group is 529.83 nmol/gm.

The values were expressed as the arithmetic mean (±) standard deviation and the number of rabbits/group = 5.

The different letters mean to indicate that there is a fundamental difference at this level.

Discussion

A vital increase has been already shown in the present study concentrations of SSH, ICSH, and Testosterone in the two groups of rabbits treated with Coenzyme Q10 and sodium selenate compared to the control group and the group of rabbits exposed to oxidative stress induced by using 0.5% of H_2O_2; the reason may be because CoQ10 and selenium are antioxidants that directly or indirectly affect free radicals and enhance the antioxidants in the testicular tissue that positively affect the germ layers and reduce oxidative damage[20], also the ability of CoQ10 and selenium to inhibit the secretion of stress hormones such as cortisol and cortisone, in addition to their ability to stimulate the secretion of the noradrenaline hormone, which affects steroid hormones[21]. In addition, selenium is necessary for the activity of the glutathione peroxidase enzyme[22], thus protecting the testicle from oxidative damage caused by free radicals and increasing the secretion of testosterone[23].

Sex hormones are among the hormones most affected by oxidative stress, as Owen[24] pointed to an imbalance in the levels of sex hormones in rabbits exposed to oxidative stress, and from our results, it was concluded that hydrogen peroxide treatment caused a significant decrease in the concentrations of male sex hormones, the reason may be due to the stressful hydrogen peroxide effect[25] and that stress often will have some consequences as it is expressed in this research. It stimulates many Hormones like (CRH), Hormone (ACTH), and The adrenal cortex to secrete cortisol[26] and the increase in the secretion of ACTH, in turn, inhibits the secretion of gonadotropin-releasing hormone (GnRH), which negatively affects the secretion of SSH and ICSH[27].

The decrease in the concentration of Glutathione in cases When there is this oxidative stress due to a reduction of the effectiveness of the Pentose shunt in these cases[28], as the enzyme activity G-6-PDH, which is necessary for the activity of its conversion to Pentose, and thus the formation of NADPH decreases. GSH-RD is unable to reduce the oxidized form of GSSG. Consequently, there will be a decrease in the concentration reduced GSH occurs. It is noted from the results that the GSH decreased as a result of treatment with hydrogen peroxide, and this was accompanied by the noticed concentration increase in the MDA as a result of the increase in lipid peroxidation, which rises due to the imbalance between antioxidants and oxidants.

The decrease in MDA concentration when treated with coenzyme Q10 and sodium selenate indicates a decrease in the hydrolysis of unsaturated fatty acids in biological membranes, the reason for the improvement in the concentration of Glutathione in the group of rabbits treated with coenzyme Q10 and sodium selenate may be due to the fact that they are antioxidants and play a significant role in scavenging free radicals, in addition to the role of coenzyme Q10 in the respiratory chain, being one of the essen-

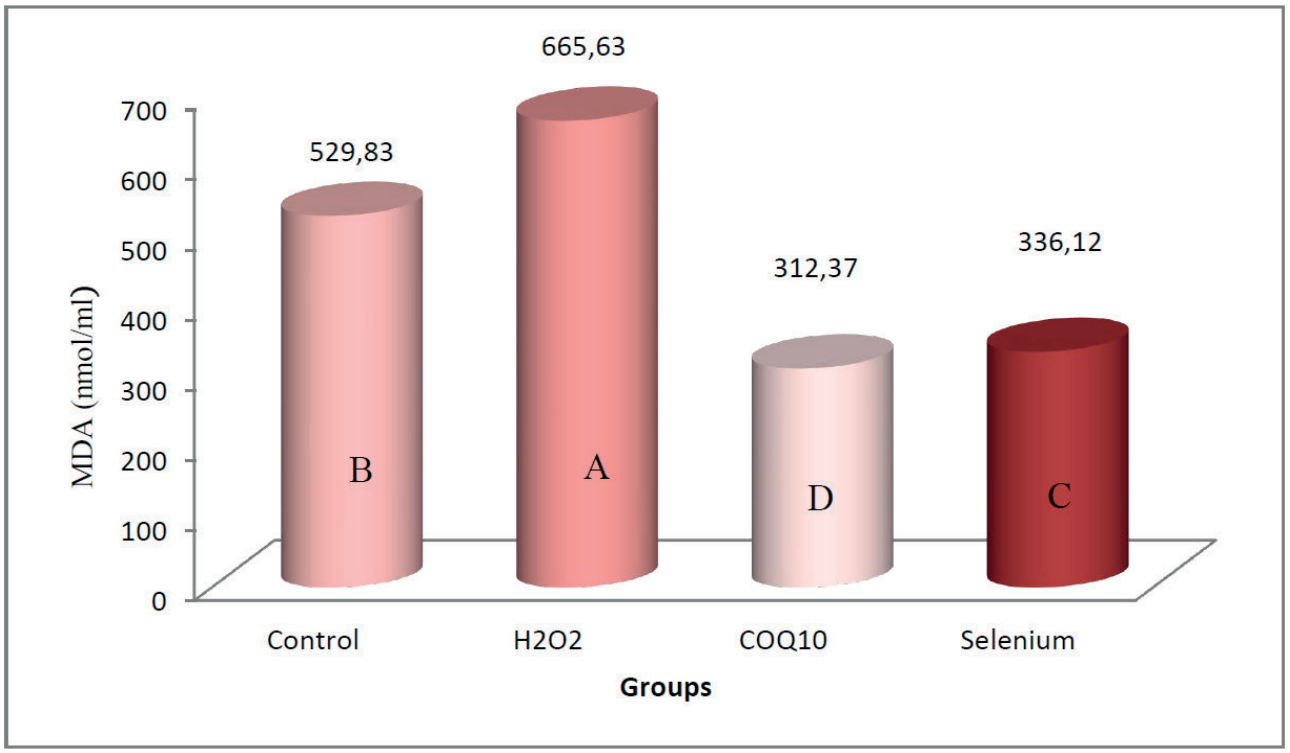

Figure 5. Shows the effect of coenzyme Q10 and sodium selenate on the concentration of Malondialdehyde (nmol/ml) in rabbits exposed to oxidative stress.

tial compounds for energy production during the process of electron transfer and oxidative phosphorylation, Coenzyme Q10 also possesses antioxidant properties due to the nature of its composition and content of phenols, because of its close location to unsaturated fatty acids in the cell membrane[29] and because of its fat-soluble nature, it inhibits the lipid oxidation process in the cell membrane and keeps the LDL-c proteins present in the blood circulation from oxidation, which is the primary transporter in the blood, as 80-90% of coenzyme Q10 in the blood serum is in the form of Ubiquinol is dissolved in lipoprotein molecules[30] thus, it may provide the necessary protection for DNA from the harmful effects of free radicals, including preventing mutations or damage to DNA and cell death[31].

Conclusions

The present study investigated the effects of oxidative stress induced by hydrogen peroxide (H_2O_2) on testicular function in rabbits and the protective effect of Coenzyme Q10 (CoQ10) and sodium selenate. The results showed that H_2O_2 treatment caused a significant decrease in the concentrations of sex hormones (SSH, ICSH, and testosterone), glutathione (GSH), and an increase in the concentration of malondialdehyde (MDA). Treatment with CoQ10 and sodium selenate significantly reversed the effects of H_2O_2, increasing the concentrations of sex hormones, GSH, and decreasing the concentration of MDA. CoQ10 and sodium selenate have a protective effect on testicular function against oxidative stress induced by H_2O_2. They suggested that this protective effect may be due to the antioxidant properties of CoQ10 and selenium, which can scavenge free radicals and protect against lipid peroxidation.

Is also discussed the role of stress hormones in the effects of H_2O_2 on testicular function. They suggested that the increase in stress hormones caused by H_2O_2 may inhibit the secretion of gonadotropin-releasing hormone (GnRH), which negatively affects the secretion of SSH and ICSH.

Overall, the present study provides valuable information on the effects of oxidative stress on testicular function and the protective effect of CoQ10 and sodium selenate. The findings suggest that these antioxidants may be useful for protecting the testicles from oxidative damage and improving testicular function in men.

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Conflicts of Interest

The authors declare no conflict of interest.

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