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Effect of Coenzyme Q10 Doses on Hepatic Energy Status and Liver Function in Healthy Male White Rats

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Abstract

Coenzyme Q10 plays a pivotal role in the electron transport chain within the mitochondria, which is actively involved in adenosine triphosphate production, thereby positively affecting the efficiency of cellular energy production. Therefore, the present study aimed to evaluate the effect of CoQ10 on the hepatic energy status and certain liver parameters in healthy male white rats. The study was conducted on 24 white rats weighing between 220 and 240 g, which were randomly assigned to four groups: The control group (C) served as the negative control and was administered physiological saline, while three groups received CoQ10 at graduated doses: group (T1): which consisted of animals administered CoQ10 at a concentration of 10 mg/kg body weight for 30 days, and Group T2: consisted of animals administered CoQ10 at a concentration of 20 mg/kg body weight for 30 days, and the fourth group, T3: consisted of animals administered CoQ10 at a concentration of 30 mg/kg body weight for 30 days. After the experiment, the following parameters were examined: ATP levels in liver tissue, which are the primary indicator of hepatic energy status; liver enzyme levels, including alanine aminotransferase (ALP), total protein, and albumin in serum. The results showed that rats receiving varying doses of CoQ10 exhibited a stimulatory effect on ATP levels increased with higher CoQ10 doses, while no change in ALT levels was observed compared to the control group; in contrast, there was a slight increase in total protein and albumin levels compared to the control group.

Keywords:
Coenzyme Q10, adenosine triphosphate (ATP), alanine aminotransferase (ALP), total protein, albumin.

Introduction:

The liver is one of the body's most vital organs, responsible for metabolic processes, most notably maintaining the body's internal homeostasis by aiding in the metabolism of carbohydrates, fats, and proteins, continuous cellular activity, and high energy levels. This makes mitochondria an essential component in maintaining the efficiency of liver cells (3).

Adenosine triphosphate (ATP) is the primary source of renewable energy within cells; therefore, its levels serve as an important indicator of cellular energy status and mitochondrial efficiency (9).

Coenzyme Q10 is a lipid compound naturally found in mitochondrial membranes that plays a key role in the electron transport chain by transferring electrons between components of the respiratory chain, thereby supporting oxidative phosphorylation and ATP production. CoQ10 also possesses antioxidant properties that help support cellular function while maintaining the integrity of cell membranes (11).

Experimental studies have shown that CoQ10 supplementation can positively influence liver function and mitochondrial activity. Another systematic review also indicated that the effect of CoQ10 on liver enzymes may vary depending on the physiological or pathological condition, as well as the dose and duration of treatment, underscoring the need for further experimental studies to determine the effect of CoQ10 under normal conditions (3).

Liver function can be assessed using certain biochemical markers in serum; the blood level of alanine aminotransferase (ALT) serves as an indicator of liver cell integrity, while total protein and albumin are associated with synthetic capacity. It is associated with cellular biosynthetic capacity (11).

A study also showed that rats exhibited improvements in mitochondrial biomarkers in liver cells, which contributed to ATP production and succinate dehydrogenase activity, particularly in cases where mitochondrial function was impaired (7).

Although studies have addressed the antioxidant and hepatoprotective effects of CoQ10 in various models of liver damage, focusing on hepatic energy status in healthy animals—using ATP as a key indicator and correlating it with traditional markers of liver function—represents an aspect worthy of investigation. Accordingly, the present study to evaluate the effect of CoQ10 on ATP levels in liver tissue, as well as on ALT, total protein, and albumin in serum, in healthy male white rats, while investigating the possibility of a dose-dependent response.

Materials and Methods

The experiment was conducted at the Animal Laboratory of the College of Science at Al-Qadisiyah University, following the Animal Research:

Reporting of in Vivo Experiments guidelines and adhering to the institution's regulations for the care of laboratory animals. The experiment included 24 adult male white rats weighing between 220 and 240 g and aged between 3 and 4 months, which were housed in a controlled laboratory environment with a temperature of 22 ± 2°C, a humidity level of 5 ± 55, and light/dark cycles ranging from 14 to 10 h. The animals were provided with water and feed throughout the experiment and were allowed to acclimatize to the new environmental conditions for one month before the experiment began. They were then randomly divided into four groups, each consisting of six animals, and were subsequently given coenzyme Co Q10 at various doses over a 30-day period.

Coenzyme Q10:

The supplement was obtained from a pharmacy and administered to the animals after being dissolved in olive oil according to the doses used in the experiment: 10 mg, 20 mg (12), and 30 mg/kg of body weight (2), and the animals were administered the supplement throughout the duration of the experiment.

Experimental Design:

The experimental animals were randomly assigned to four groups, each consisting of six animals.

The first group served as the control group (C) and was administered physiological saline for 30 days; the second group (T1) was administered CoQ10 at a concentration of 10 mg/kg body weight for 30 days. The third group (T2) was administered CoQ10 at a concentration of 20 mg/kg body weight for 30 days. The fourth group (T3) was administered CoQ10 at a concentration of 30 mg/kg body weight for 30 days.

Sample Collection:

At the end of the experiment, the animals were anesthetized with chloroform to collect blood serum via cardiac puncture for the necessary biochemical tests. The animals were then euthanized to collect liver tissue and measure ATP levels therein. It should be noted that no unexpected deaths occurred during the experiment.

Measurement of Liver Function

To assess the activity of the transaminase enzymes ALT, AST, and ALP, we followed the colorimetric method described in a previous study (5).

Serum albumin and total protein levels were measured using the following formula (6).

Study of ATP Levels in Liver Tissue

A set of animal liver tissue samples was excised and washed with a 0.9% sodium chloride solution to remove blood residues and adherent tissue. After weighing, the samples were cut and frozen in liquid nitrogen to preserve their chemical composition. They were then ground into a fine powder. To facilitate the extraction of cellular components from the samples, they were placed in a phosphate-buffered saline solution and subsequently centrifuged for 10 seconds (4).

The ATP level was then measured using an enzyme-linked immunosorbent assay (ELISA) for rats, in accordance with the manufacturer's instructions (Catalog No. SL1512Ra, Lot No. 20260201; Sunlong Biotech Co. Ltd., Shanghai, China), and read by a Huma Reader HS Germany) reader ELISA (4).

Statistical analysis

The results of the experiments were analysed using the SPSS statistical program, as the least significant differences (LSD) were used to express the data, and the test was used. ANOVA) for multiple comparisons between the studied groups and the control group, and the least significant difference was calculated to test the significance of the results.

Results and Discussion

Table (1) shows the effect of CoQ10 on ALP, ALT, and AST levels in the serum of male rats at different concentrations of Q10.

Group / Parameters	C	T1	T2	T3	LSD
ALP(U/L)	91.5±9.3 ^a	91.3±10.3 ^a	90.8±3.8 ^a	90.2±7.5 ^a	9.77
ALT(U/L)	22.2±4.3 ^a	22.1±4.1 ^a	22.3±2.1 ^a	22.4±2.2 ^a	4.02
AST(U/L)	41.5±5.2 ^a	41.4±6.1 ^a	40.9±5.0 ^a	40.5±4.3 ^a	6.25

Values are expressed as mean ± standard deviation (n=6). Means with different superscript letters within the same row are significantly different ($p < 0.05$). C: Control. C: Control group; T1: given Coenzyme Q10 concentration 10 ml/kg. group; T2: given Coenzyme Q10 concentration 20 ml/kg. group; T3 given Coenzyme Q10 concertation 30ml/kg

The results in Table (1) confirmed that different doses of coenzyme Q10 did not affect liver enzyme levels compared to the control group; this may be attributed to the harmless protective effect of Q10 on liver tissue, as well as its role as an antioxidant that helps maintain the balance of organ cell functions (1).

Table (2) shows the effect of Coenzyme Q10 on in Albumin& Total protein the serum of male rats in deferent concentration of Q10.

Group / Parameters	C	T1	T2	T3	LSD

Albumin(gLdL)	1.30±0.19 ^c	2.10±0.18 ^b	2.30±0.19 ^b	2.60±0.20 ^a	0.23
Total protein(gLdL)	2.10±0.07 ^c	2.10±0.06 ^c	2.30±0.06 ^b	2.50±0.07 ^a	0.08

Values are expressed as mean ± standard deviation (n=6). Means with different superscript letters within the same row are significantly different (p < 0.05). C: Control. group; T1: given Coenzyme Q10 concertation 10 ml/kg. group; T2: given Coenzyme Q10 concentration 20 ml/kg. group; T3 given Coenzyme Q10 concentration 30 ml/kg.

The results showed a slight increase in albumin and total protein levels compared to the control group, which recorded an albumin level of (1.30±0.19) and a total protein level of (2.10±0.07) compared to groups T1, T2, and T3. This may be attributed to the fact that total protein and albumin levels are directly related to the synthetic capacity of liver cells, and the different doses of Coenzyme Q10 may have contributed to increased activity of liver cells in producing ATP, which in turn contributed to this slight increase (8) (Table 2).

Table (3) shows the effect of Coenzyme Q10 on ATP in the liver tissue of male rats at different concentrations of Q10.

Groups / Parameters	C	T1	T2	T3	LSD
ATP(pg/ml)	5.55±0.6 ^d	7.13±0.6 ^c	9.25.6±0.8 ^b	12.55±0.9 ^a	1.32

Values are expressed as mean ± standard deviation (n=6). Means with different superscript letters within the same row are significantly different (p < 0.05). C: Control. group; T1: given Coenzyme Q10 concertation 10 ml/kg. group; T2: given Coenzyme Q10 concentration 20 ml/kg. group; T3 given Coenzyme Q10 concertation 30ml/kg.

The results confirmed a significant increase in ATP levels in liver tissue in the groups exposed to escalating doses of CoQ10 compared to the control group, which had a level of (5.55±0.6), whereas the level in the T1 group was (7.13±0.6) and in the T2 group (9.25 ± 0.6), while the T3 group recorded a level of (12.55 ± 0.9), which was the highest compared to the control group and the other groups. This may be attributed to the response of liver tissue cells to the protective role of CoQ10 at different doses, as well as its role as an enzyme activator that enhances cellular function; through its antioxidant properties, it helps protect cellular tissue from free radicals (10). (Table 3).

Conclusion

The results of the current study showed that administration of coenzyme Q10 (CoQ10) had a positive effect on liver tissue cell function in healthy male white rats over the 30-day duration of the experiment, as evidenced by increased ATP levels, which had a positive impact on liver tissue in conjunction with higher doses of CoQ10. Furthermore, administration of CoQ10 at doses of 10, 20, and 30 mg/kg body weight for 30 days did not result in any noticeable changes in liver enzyme levels (ALP, ALT, AST) in serum, suggesting no significant effect on liver function damage with progressive dose escalation.

Furthermore, a slight increase in total protein and albumin levels was observed compared to the control group, which may indicate a potential positive effect of CoQ10 on liver function and protein synthesis. Overall, the results suggest that CoQ10 supplementation effectively contributed to enhancing energy production in the liver by improving mitochondrial efficiency, while maintaining normal liver function in healthy rats; the 30 mg/kg dose was the most effective in increasing hepatic ATP levels.

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