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Effects of Daily Added Coenzyme Q₁₀ on Certain Haematological and Biochemical Parameters in Elite Endurance Skiing Athletes

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Abstract

The present study aims to examine the effects of orally administered coenzyme Q₁₀ (CoQ₁₀) supplement on certain haematological and biochemical parameters in regularly exercising elite endurance athletes. The study subjects were divided into three groups, namely the control group (n = 5) and two subject groups taking 100 mg (n = 5) and 200 mg (n = 5) CoQ₁₀. The blood samples thus collected were utilized for the measurement of certain haematological and biochemical parameters and CoQ₁₀ levels. In the present study, regular exercise and administration of 100 mg and 200 mg of CoQ₁₀ led to an increase in MCV, MCHC and HGB levels (p<0.05 and p<0.01, respectively) and a decrease in WBC. In addition, significant increases were identified in the AST and ALT levels of the control group when compared to the trial groups (p<0.01), while an increase was also observed in glucose and Creatin in the group taking 200 mg of CoQ₁₀ (p<0.05). When the pre- and post-exercise results in CoQ₁₀ levels were compared, increases were determined in the CoQ₁₀ levels of trial groups using 100 mg and 200 mg of CoQ₁₀ (p<0.05 and p<0.01, respectively). Consequently, certain haematological and biochemical parameters are considered to potentially increase or decrease as a result of a physical exercise-related enhancement in metabolic activity, in oxygen consumption and thus, in the formation of reactive oxygen species. Therefore, the administration of CoQ₁₀ can be argued to be effective on blood parameters and to support the antioxidant defence system.

Keywords: *Exercise, Coenzyme Q₁₀, Skiing Athlete, Haematological and Biochemical Parameters*

1. Introduction

Coenzyme Q₁₀ (CoQ₁₀ or Ubiquinone) widely occurs in human organisms and tissues. It is used as a food supplement, in cosmetic formulations and as an ethical drug because of its antioxidant functions and key role in mitochondrial bioenergetics (Fu et al, 2009). The decreased biosynthesis of CoQ₁₀ and its deficit in tissues is associated with degenerative changes of aging. Therefore, CoQ₁₀ dietary supplementation has become helpful for organism and recently it is used for daily health care worldwide. Because of the hydrophobicity and large molecular weight of CoQ₁₀, the absorption of dietary CoQ₁₀ is slow and limited (Singh et al, 2005). In addition to its supplementation has been touted to improve physical and athletic stamina, muscle fatigue and weakness (Eric et al, 1992 and Kei et

al, 2008). CoQ₁₀ is biosynthesized and concentrated in the heart, kidneys, liver, muscle, pancreas and thyroid gland (Kwong et al, 2002).

CoQ₁₀ is very important in energy generation and is a significant protector against reactive oxygen species. Changes in energy generation affect physical performance. At the same time, physical exercise is considered to increase metabolic activity and oxygen consumption and thus, the formation of reactive oxygen species leading to muscle fatigue and related oxidative damage, whereas the use of CoQ₁₀ is thought to relieve oxidative stress, to improve physical performance and to assist in the energy generation process in mitochondria (Ylikoski et al, 1997 and Cooke et al, 2008). As is the case with numerous other factors inclu-

ding an individual's adjustment to exercise, the adaptation of cardiovascular activity and physical, physiological balance, haematological and biochemical levels can also play important roles in the regulation of the physiological response. Depending on the type, severity and duration of exercise, changes can be observed in haematological and biochemical parameters. Haematological changes are identified in athletes with relation to long-term exercise (Arslan et al, 1997 and Banfi et al, 2006). Athletes that implement an intensive exercise program demonstrate characteristic decreases in blood values, which are also considered as athlete's anaemia (Çakmakçı, 2009). The present study aimed to examine the pre- and post-exercise effects of a daily supplement of CoQ₁₀ on certain haematological and biochemical parameters in elite endurance athletes.

2. Materials and Methods

2.1. Samples

The study population consisted of 15 volunteering undergraduate male athletes with a mean age of (21,66 ± 0,58), mean weight of (64,93 ± 2,80) and a mean height of (1,76 ± 0,01). Conducted in line with the relevant directive specified in Helsinki Declaration, the study obtained approval from the Local Ethics Committee and ensured voluntary participation by providing study subjects with information on the objective of the study before the measurements. The study subjects were divided into three groups, namely the control group and two subject groups taking 100 mg and 200 mg CoQ₁₀. An oral supplement of CoQ₁₀ was administered to the study subjects at 8.30 in the morning during the period of 14 days and their blood samples were collected both before and after exercise. For a period of 14 days, each one of the 3 groups was made subject to a training load of 70-80% and repetitions making up 2 hours in total once every day. The exercise program was systematically adjusted specifically for each group to obtain the most suitable effects in physiological terms. Preparations of 100 and 200 mg of CoQ₁₀ were given to the athletes to be taken after dinner. The exercises were repeated in the same manner as the first day for a period of 14 days.

2.2. Blood Sampling

The blood samples of the athletes were collected in tubes containing anticoagulant Lithium Heparin once before exercise, and immediately after the training for a period of two weeks. The blood samples thus collected were centrifuged at 4000 rpm for 15 minutes, taken into polypropylene tubes with a cap on the top plasma part and kept at -80°C in deep freeze until CoQ₁₀-related Haematological and Biochemical parameters were checked in plasma.

2.3. Determination of Haematological Parameters

The blood samples were kept at -80°C in deep freeze until haematological parameters were checked. Then, the blood samples were submitted to the Central Laboratory of the Faculty of Medicine of Kafkas University for the determination of such blood levels as leukocyte (WBC) and erythrocyte (RBC) counts, haemoglobin (HGB), haematocrit (HCT), mean erythrocyte haemoglobin concentration (MCHC), mean erythrocyte haemoglobin (MCH), Platelet (PLT), mean erythrocyte volume (MCV) and platelet (PCT).

2.4. Determination of Plasma CoQ₁₀ Levels

For the determination of CoQ₁₀ levels, a 50 µl solution of 1,4-benzoquinone was added to plasma of 200 µl (2 mg/ml) and the end product was vortexed for 10 seconds. 1 ml n-propanol was added to the product after 10 minutes. Following the vortexing of the tube for 10 seconds, 2 minutes of centrifugation was applied at 10.000 rpm to precipitate protein. The content was then injected into supernatant HPLC of two hundred micro-litres. It was transferred into a supernatant capped test tube that is capable of maintaining activity for 3 days at ambient temperature (22 °C). The flow rate was 1 ml/minute following the composition of the mobile phase with ethanol-methanol (65-35%). The UV measurement was performed at 275 nm (Mosca et al, 2002).

2.5. Determination of Biochemical Parameters

The analyses of blood samples for Glucose (Glu), Urea, Creatin (Cr), Calcium (Ca), albumin (Alb), Sodium (Na), Potassium (K), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were performed at the Central Laboratory of the Medical Faculty of Kafkas University.

2.6. Statistical Analysis

The statistical analysis of the data was conducted on the SPSS 17.0 software. The data were expressed as mean ± standard deviation. Comparisons were performed between the variables among groups through the t-test and between in-group variables through the paired t-test. P values lower than 0.05 were regarded as significant.

3. Results

As a result of the comparison between pre- and post-exercise CoQ₁₀ levels, no change was observed in the control group, while an increase was determined in the CoQ₁₀ values of the trial groups using 100 mg and 200 mg of CoQ₁₀ (p<0.05 and p<0.01, respectively). The pre- and post-exercise changes in the 14-day CoQ₁₀ administration among elite athletes are shown in Figure 1.

When the pre- and post-exercise haematological paramet-

ers of athletes were compared, no significance was observed in the MCV, RBC, HGB, HCT, WBC, PCT, PLT, MCH and MCHC values of the control group, whereas consistent increase with the CoQ₁₀ administration was identified in the MCV and MCHC levels of trial groups ($p < 0.05$ and $p < 0.01$, respectively). On the other hand, a significant increase in the WBC levels ($p < 0.05$) and a significant increase in the HGB levels ($p < 0.01$) were observed in the group using 200 mg of CoQ₁₀ (Figure 2 and Table 1).

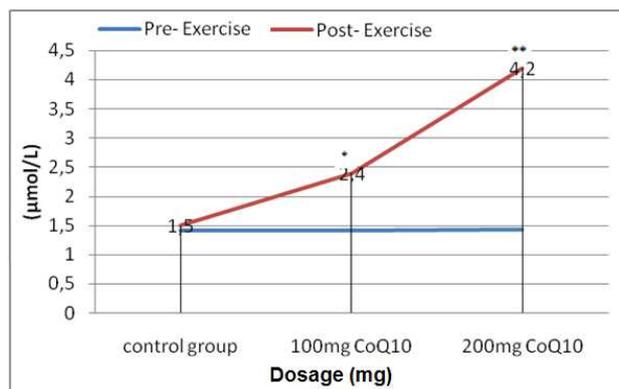


Figure 1. Pre- and Post-Exercise Changes in the 14-day CoQ₁₀ Administration among Elite Skiers

** $p < 0.01$, * $p < 0.05$

Table 1. Effects of 14-Day CoQ₁₀ Use on the Pre- and Post-Exercise Haematological Parameters of Elite Skiers ($\bar{X} \pm SD$)

Parameters	Control Group (n=5)		100mg CoQ ₁₀ Group (n=5)		200 mg CoQ ₁₀ Group (n=5)	
	Pre- Ex	Post- Ex	Pre- Ex	Post- Ex	Pre- Ex	Post- Ex
MCV	86,8 ± 1,64	86,8 ± 1,64	85,2 ± 3,96	89,2 ± 7,48*	87,4 ± 3,04	95,8 ± 4,65*
RBC (103/µl)	5,43 ± 0,14	5,41 ± 0,16	5,52 ± 0,25	5,37 ± 0,22	5,55 ± 0,32	5,51 ± 0,31
HGB (g/dl)	15,86 ± 0,55	15,84 ± 0,54	15,71 ± 1,73	16,1 ± 1,74	16,0 ± 0,34	17,0 ± 0,19**
HCT	47,0 ± 1,55	46,98 ± 1,55	47,11 ± 4,09	46,6 ± 3,74	48,5 ± 1,86	47,3 ± 1,85
WBC (103/µl)	8,64 ± 3,40	8,64 ± 3,38	7,90 ± 2,79	7,74 ± 2,78	7,98 ± 0,91	7,76 ± 0,90*
PCT (%)	190,4 ± 30,3	190,2 ± 29,7	196,0 ± 54,6	196,4 ± 54,7	194,8 ± 23,3	194,6 ± 23,0
PLT (103/µl)	243,6 ± 47,6	244,0 ± 48,8	243,8 ± 51,0	244,2 ± 51,4	249,6 ± 53,2	249,2 ± 52,5
MCH (pg)	29,5 ± 1,24	29,5 ± 1,24	28,4 ± 2,34	28,6 ± 2,24	29,5 ± 0,94	29,4 ± 1,01
MCHC (g/dl)	33,9 ± 1,05	34,0 ± 1,10	33,5 ± 0,85	35,2 ± 0,64**	33,7 ± 0,20	35,5 ± 0,44**

** $p < 0.01$, * $p < 0.05$, Pre-Exercise (Pre- Ex.), Post-Exercise (Post-Ex), leukocyte (WBC) and erythrocyte (RBC) counts, Haemoglobin (HGB), Hamatocrit (HCT), Mean Erythrocyte Haemoglobin Concentration (MCHC), Mean Erythrocyte Haemoglobin (MCH), Platelet (PLT), mean erythrocyte volume (MCV) and platelet (PCT)

The comparison between the pre- and post-exercise biochemical parameters of athletes, no significant change was observed in the Glu, Urea, Cr, Na, K, Alb and Ca values of the control group, while significant increases were identified in the AST and ALT levels of the control group with relation to the trial groups ($p < 0.01$). On the other hand, increases were determined in the Glucose and Creatin values of the trial group using 200 mg of CoQ₁₀ ($p < 0.05$).

However, contrary to the control group, AST and ALT values of the trial groups demonstrated decreases with a significance of $p < 0.05$ (Figure 3 and Table 2).

4. Discussion

The question as to what most important factor in exercise is, the concept of "Energy" seems to come in prominence. Muscle contraction occurs through energy consumption. The manner and amount of such energy consumption mainly depend on the athlete's performance and the type, severity and duration of exercise. During exercise, CoQ₁₀ is an essential catalyser that is necessary for energy generation at cellular level (Burton et al, 2004 and Kei et al, 2008). The oxygen and energy needs of muscles during exercise increase in parallel with the increase in the need to remove metabolites and carbon dioxide. Along with these increased demands, chemical, mechanical and thermal stimulants lead to changes in metabolic, cardiovascular and respiratory functions, which, in turn, affect homeostasis (Gürkan et al, 2005 and Shinde et al, 2005). Giving way to the generation of energy and ATP formation in the mitochondria of cells to enable the organism to tolerate such changes, CoQ₁₀ is an essential catalyser to ensure adaptation to highly intensive physiological activities in muscle tissue (Scott, 2008). Relevant studies in the literature reports that CoQ₁₀ administered before exercise

improves the plasma CoQ₁₀ level (Ylikoski et al, 1997 and Bonetti et al, 2000). Comparing the pre- and post-exercise CoQ₁₀ levels, our study determined an increase in the CoQ₁₀ levels of trial groups, while no significant change was observed in the control group.

As blood parameters affect the type and intensity of exercise, exercise also affects blood parameters (Çakmakçı,

2009).

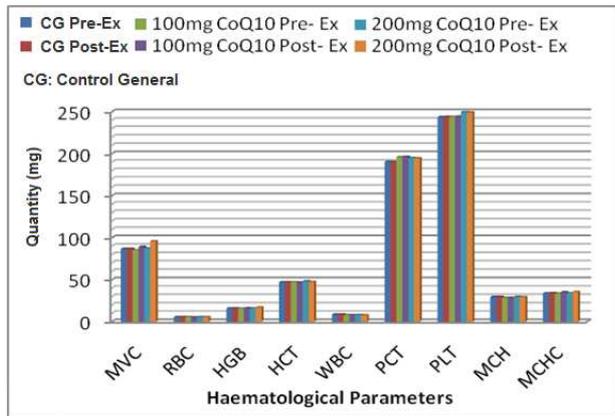


Figure 2. Changes in the Pre- and Post-Haematological Parameters of Elite Skiers Using CoQ₁₀ for 14 Days

** $p < 0.01$, * $p < 0.05$, Pre-Exercise (Pre-Ex.), Post-Exercise (Post-Ex), leukocyte (WBC) and erythrocyte (RBC) counts, haemoglobin (HGB), haematocrit (HCT), mean erythrocyte haemoglobin concentration (MCHC), mean erythrocyte haemoglobin (MCH), Platelet (PLT), mean erythrocyte volume (MCV) and platelet (PCT)

et al (2000) reported significant increases in HGB levels after the exercise programs implemented within the scope of their studies. These reports support our findings. In our study, when the pre- and post-exercise haematological parameters of athletes were compared, no significance was observed in the MCV, RBC, HGB, HCT, WBC, PCT, PLT, MCH and MCHC values of the control group, whereas an increase consistent with the CoQ₁₀ administration was identified in the MCV and MCHC levels of trial groups. On the other hand, a significant decrease in the WBC levels and a significant increase in the HGB levels were observed in the group using 200 mg of CoQ₁₀. Although the post-exercise increase in the HGB level is attributed to an increase in blood volume, it can be also considered to arise from the hypoxic conditions emerging during and after exercise that enable oxygen to be transferred to tissues at the needed amount. Therefore, the low concentration of CoQ₁₀ identified in the blood of athletes dealing with endurance sports like skiing during energy generation shows us that CoQ₁₀ supplement is necessary in such sports (Bloomer & Goldfarb, 2004). As it is primarily relevant to cellular energy flow and energy generation, CoQ₁₀ transfers electrons to cellular molecules and assists in the provision of energy from ATP by

Table 2. Effects of 14-Day CoQ₁₀ Use on the Pre- and Post-Exercise Biochemical Parameters of Elite Skiers ($\bar{X} \pm SD$)

Parameters	Control Group (n=5)		100mg CoQ ₁₀ Group (n=5)		200 mg CoQ ₁₀ Group (n=5)	
	Pre- Ex	Post- Ex	Pre- Ex	Post- Ex	Pre- Ex	Post- Ex
Glu (mg/dL)	82,0 ± 5,00	82,2 ± 4,80	86,4 ± 10,4	85,8 ± 10,1	71,8 ± 10,2	74,0 ± 6,92*
Urea (mg/dL)	30,4 ± 5,72	30,2 ± 5,40	23,4 ± 4,03	23,2 ± 3,49	26,4 ± 2,19	25,8 ± 2,16
Cr (mg/dL)	1,08 ± 0,10	1,08 ± 0,10	0,99 ± 0,15	1,00 ± 1,15	1,11 ± 0,08	1,16 ± 0,07*
Na (mEq/L)	140,0 ± 2,00	140,0 ± 2,12	139,2 ± 1,30	138,6 ± 1,14	141,0 ± 0,70	140,2 ± 0,44
K (mEq/L)	4,49 ± 0,33	4,48 ± 0,33	4,42 ± 0,32	4,40 ± 0,30	4,46 ± 0,14	4,45 ± 0,14
Alb (g/dL)	4,82 ± 0,27	4,82 ± 0,31	4,72 ± 0,27	4,70 ± 0,32	4,66 ± 0,13	4,60 ± 0,14
Ca (mg/dL)	10,0 ± 0,39	10,0 ± 0,33	9,90 ± 0,33	9,84 ± 0,41	10,0 ± 0,24	9,96 ± 0,27
AST (U/L)	3,27 ± 1,46	6,09 ± 2,72**	2,70 ± 1,20	3,11 ± 1,39*	2,58 ± 1,15	1,87 ± 0,83*
ALT (U/L)	26,03 ± 1,64	14,88 ± 6,65**	25,73 ± 11,51	13,87 ± 6,20*	25,70 ± 11,49	13,53 ± 6,05*

** $p < 0.01$, * $p < 0.05$, Pre-Exercise (Pre- Ex.), Post-Exercise (Post-Ex) Glucose (Glu), Urea, Creatin (Cr), Calcium (Ca), albumin (Alb), Sodium (Na), Potassium (K), Aspartate Aminotransferase (AST) and Alanine Aminotransferase (ALT)

Kratz et al (2002) reported significant increases in post-competition MCV and MCHC values in a study addressing marathon runners. Similarly, Branch et al (1997) identified a significant increase in MCV and MCHC levels of 26 healthy female study subjects following a 12-week exercise period. Nevertheless, Pouramir et al (2004) conducted a study on 35 male gymnasts that had been subject to a 10-week exercise program, and reported no significant changes in the post-program MCV and MCHC levels. Certain studies in the literature (Ylikoski et al, 1997 and Yeh et al, 2006) could not identify any significant change in post-exercise WBC levels. Nieman et al (1999) and Gallagher

contributing to the energy generation of mitochondria. Hence, increases and decreases in the pre- and post-exercise haematological parameters of athletes can be considered to be related with CoQ₁₀ use.

AST and ALT (alanine aminotransferase, aspartate aminotransferase) are tests that indicate cellular damage in the liver. In addition to myocardial diseases, muscular dystrophy, muscle trauma and intramuscular injections also demonstrate an increase in AST and ALT. High enzyme levels and increases in the concentrations of large tissue structures including the liver and skeletal muscle are indicators of

fatigue and damage (Diaz et al, 2010). Our study compared the pre- and post-exercise values and determined significant increases in the AST and ALT levels of the control group with relation to the trial groups along with the CoQ₁₀ use. However, decreases consistent with the CoQ₁₀ use were observed in the AST and ALT levels of the trial groups. These increases were determined to be more prominent in the group using 200 mg of CoQ₁₀. Exercise increases the need for energy and although they enable weight loss, the reduced glycogen stores of muscles make it difficult for the individual to maintain their exercise level and lead to the rapid development of fatigue (Bompa, 1998). The increase in metabolic activity makes way for increased generation of waste substances. At the same time, an increase is observed in the respiratory rate. The dehydration arising from these two processes cause a decrease in blood plasma and a further restraint on the circulatory system. In order for the individual to tolerate such changes, CoQ₁₀ gives way to the generation of energy or ATP formation in the mitochondria of cells and assumes the role of an essential catalyser in adaptation to highly intensive physiological activities (Scott et al, 2008). According to certain studies in the literature, CoQ₁₀ use is concluded to lead to a prominent decrease in the post-exercise AST and ALT levels (Kei et al, 2008 and Revan et al, 2013). These reports support our study.

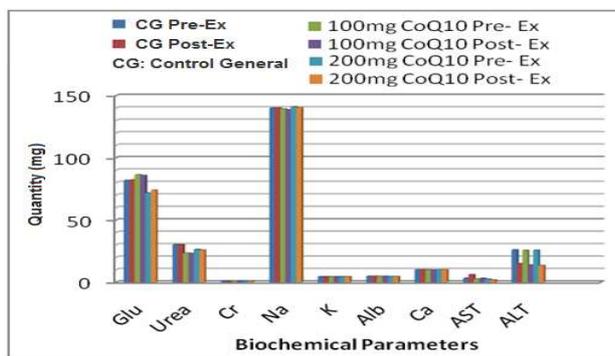


Figure 3. Effects of 14-Day CoQ₁₀ Use on the Pre- and Post-Exercise Biochemical Parameters of Elite Skiers

** $p < 0.01$, * $p < 0.05$, Pre-Exercise (Pre- Ex.), Post-Exercise (Post-Ex) Glucose (Glu), Urea, Creatin (Cr), Calcium (Ca), albumin (Alb), Sodium (Na), Potassium (K), aspartate aminotransferase (AST) and alanine aminotransferase (ALT)

In the resting period, glucose is composed, with the help of glucagon, through the breakdown of glycogen in the liver and from amino acids. During exercise, glucose increases with the help of catecholamine released from the adrenal medulla at a higher rate along with glycogenolysis and glucagon (Günay & Cicioğlu, 2001). In a study in the literature, Howlett et al (1998) reported that acute exercise increased blood glucose levels. Similarly, Stuart et al (2004) reported that the treadmill exercise led to an increase in the blood glucose level. The organism uses ATP to

satisfy its increased need for energy during exercise. ATP must be regenerated rapidly for the individual to continue to exercise. The amount of Cr utilized by skeletal muscles is associated with the intensity and duration of exercise. At the most intensive moments of exercise, the muscles depend on the Cr stores to generate energy (Wyss & Kaddurah, 2000). Considering the results obtained from the study, no significant change was identified in the Glu, Urea, Cr, Na, K, Alb and Ca values of the control group upon the comparison of pre- and post-exercise biochemical parameters of athletes. However, significant increases were observed in the Glucose and Cr values of the trial group using 200 mg of CoQ₁₀. Glucose in blood is provided from ingested carbohydrates and from glycogen in the liver. If the blood glucose level rises, the insulin hormone starts to be released. The released insulin enables excess glucose in blood to be stored as glycogen in the liver and muscles and thus, the blood glucose level is maintained. The main aim of glucose is to generate ATP (Günay & Cicioğlu, 2001). Therefore, as it is primarily relevant to cellular energy flow and energy generation, CoQ₁₀ transfers electrons to cellular molecules and assists in the provision of energy from ATP by contributing to the energy generation of mitochondria. Hence, the increase in the post-exercise glucose level of the trial group using 200 mg of CoQ₁₀ can be associated with this phenomenon. Besides, the increase in the exercise capacity can be attributed to the increase in the re-synthesis rate of ATP and in metabolic competence.

5. Conclusion

Consequently, the present study identified that regular exercise and CoQ₁₀ use did not create a significant effect on the haematological values of the control group; that an increase was observed in the MCV and MCHC levels of the trial groups in consistency with the CoQ₁₀ use; and that the group using 200 mg of CoQ₁₀ demonstrated a decrease in WBC values in the face of a significant increase in the HGB levels. These increases and decreases can be considered to be associated with CoQ₁₀ use. It can be argued that excessive muscular activity during regularly undertaken skiing exercises caused increases in the AST and ALT enzymatic activities in the control group and in the glucose and Cr levels in the group using 200 mg of CoQ₁₀, whereas CoQ₁₀ leads to the generation of energy and ATP formation in the mitochondria of cells and acts as an essential catalyser to ensure adaptation to highly intensive physiological activities, and therefore, it reduces the AST and ALT enzymatic activities that are markers for muscular damage in trial groups.

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