

Lowering of Breath Alcohol Concentration after Q10 Supplementation in Male Volunteers-A Single Blind, Cross Over Design Study on Mental Performance Following Alcohol Consumption

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Abstract

Introduction: Alcohol ingestion results in a marked decline in cerebral function and the capability to safely drive an automobile, resulting in strict regulations regarding driving under alcohol. We set out to test, if the addition of a Q10 formulation (Greenspeed®) was able to increase alcohol turnover and diminish cerebral effects, by boosting up the formation of ATP, a necessary adjunct for the synthesis of enzymes necessary to metabolize alcohol within liver cells.

Material and Methods: Following informed consent, 12 middle aged male (mean age 54 years, mean body weight 86 kg, mean height 176 cm) ingested alcoholic beverages with a high alcohol concentration (17,4 vol%) together with a standard low-fat meal. Exhaled breath alcohol concentrations (BAC) were determined (Lion Alcometer SD-400) while at the time, the symbol digit modality test (SDMT) was used to determine mental performance. Thereafter, they were given 25 ml of the Q10 formulation. Nd within one hour, again both parameters were evaluated to determine differences. Following a wash-out period of 2 weeks, the same volunteers underwent the same battery of test having ingested the same amount of alcoholic beverages, which however was followed by a placebo solution having the same color and taste as the previous Q10 formulation.

Results: Following the uptake of the alcoholic beverages, breath alcohol levels increased significantly to a mean 0.55 ppm, which at the same time induced marked cerebral dysfunction ($p < 0.001$). One hour after adding Q10, there was a reduction in BAC by a mean of 0.18 ppm to the prior value ($p < 0.005$), which also resulted in a significant recovery ($p < 0.005$) of mental performance compared to previous value, but also to placebo.

Discussion: Q10 is able to boost the alcohol degradation within the liver, but also in the brain, being the cause for the recovery. This is due to the increase of synthesis of ATP within the mitochondria in liver as well as the brain cells, where Q10 is the necessary requirement for the formation of degrading enzymes. Q10 may also serve a protective agent for the cells being attacked by alcohol metabolites such as acetaldehyde and acetoacetate.

Keywords: Breath Alcohol Concentration; Q10 Formulation

Introduction

Alcohol is one of the most widely consumed psychoactive substances in the world. This drug exerts a considerable influence on the cardiovascular system [1,2] and behavioral mood state [1,3]. In this respect alcohol generally tends to have sedating effects [4] as it affects the central nervous system (CNS), with diverse actions on several neurotransmitter systems. When a low dose of alcohol is ingested, the dopaminergic, serotonergic, and noradrenergic systems are stimulated [5]. On the one hand, intake of high doses of alcohol produce

a reduction of dopaminergic and noradrenergic transmission, while the gamma-aminobutyric acid (GABA) general central depressant actions are potentiated through ethanol-induced enhancement of its binding to the GABA_A receptor complex [5], all of which markedly impair neurocognition.

Because of such side-effects we hypothesized that boosting the liver cells in the metabolic breakdown of alcohol by use of a commercially available Q10 formulation (Greenspeed®), it might result in a faster decline of alcohol levels and a faster recovery of mental concentration capabilities. This ultimately would give the person back their ability to operate sufficiently without a hangover.

Material and Methods

12 healthy middle-aged otherwise healthy subjects (Table 1) after ingesting 2 different alcoholic beverages consisting of 750 ml of red wine with an alcohol content of 15.4% plus 2 dl of mulled wine over a period of 2 hours together with a standard low-fat meal, were incorporated in the study. Before, after drinking the alcoholic beverages, and one hour after additional ingestion of 25 ml of the Q10 formulation Greenspeed® breath alcohol concentrations (BAC) were measured. The composition of the Q10 formulation having sufficient bioavailability and also efficacy on ATP synthesis in mitochondria, is described in details elsewhere [6].

By using a lightweight, portable, Lion Alcometer SD-400 test device (Labtest Services Ltd, Wolfen Switzerland), which was calibrated for altitude differences and being light weighted, provided immediate results. Since the breath analyzers measures the alcohol that passes through alveoli air sacs as blood flows through vessels in the lungs, and then is expelled in the exhaled breath, subjects were instructed to inhale deeply after which they did a forced max expiration in order to obtain the alcohol content as close as possible to blood alcohol.

Following a wash-out period of 2 week the same subjects ingested the same alcoholic beverages, however this time followed by the ingestion of a placebo solution, which by looks and by taste had a similar appearance like the previous Q10 formulation. Informed consent was obtained from all participants and the study was conducted in accordance with the Declaration of Helsinki. The inclusion criteria were as follows: 30 years of age or older, a body mass index of 27 - 30, and good health (as reported by the subjects themselves). The exclusion criteria were as follows: being on a medication, a history of mental disorders, an irregular sleep pattern during the night before the experiment, a history of substance abuse, and intake of caffeine, alcohol, or tobacco during the afternoon or the night prior to the experiment, except in the case of the habitual consumers.

In addition, in order to evaluate the effect alcohol had on neurocognitive capabilities of the subjects, and to which extend this was altered or even reversed by the addition of the Q10 formulation, the oral version of the symbol digit modality test (SDMT) for mental performance was administered [7]. In this test procedure, the subject was given a sheet of paper at the top of which the key (9 abstract symbols and 9 corresponding numbers, figure 1) were printed. The subject was presented with a page headed by a key that paired the single digits 1 - 9 with nine symbols. Since the rows below contained only symbols, the subject's task was to orally report the correct number in the spaces below. After completing the first 10 items with guidance, the subject was timed to make as much responses within a time limit of 90 seconds. In the present study the oral administration of the SDMT response task was conducted to diminish the sensory motor impact when using the written version. Thus, the examiner used as a scorer recording the subject's voiced responses. The correct answers appeared on the examiner's form making scoring quicker, with a minimal chance for error. In total, the test required no more than 5 minutes to complete. Repetitive studies have shown that the SDMT test discriminates better in regard to other neurocognitive ailments than all other neuropsychological tests [8-10].

This key was available to the subject throughout the test where the subject had to evaluate a sequence of 120 symbols, each printed in a square then was presented below the key. Empty squares were located below the squares containing the symbols. A representative example of key sequence and the first line of the test is reproduced in figure 1. In the oral version, the examiner, on a copy of the test sheet,

recorded in the empty squares the numbers the subject associated orally with the symbols. The subject had to make as many associations as possible within the 90-seconds time limit, while the final scoring consisted of the number of correct associations which had been made by the subject [7,11].

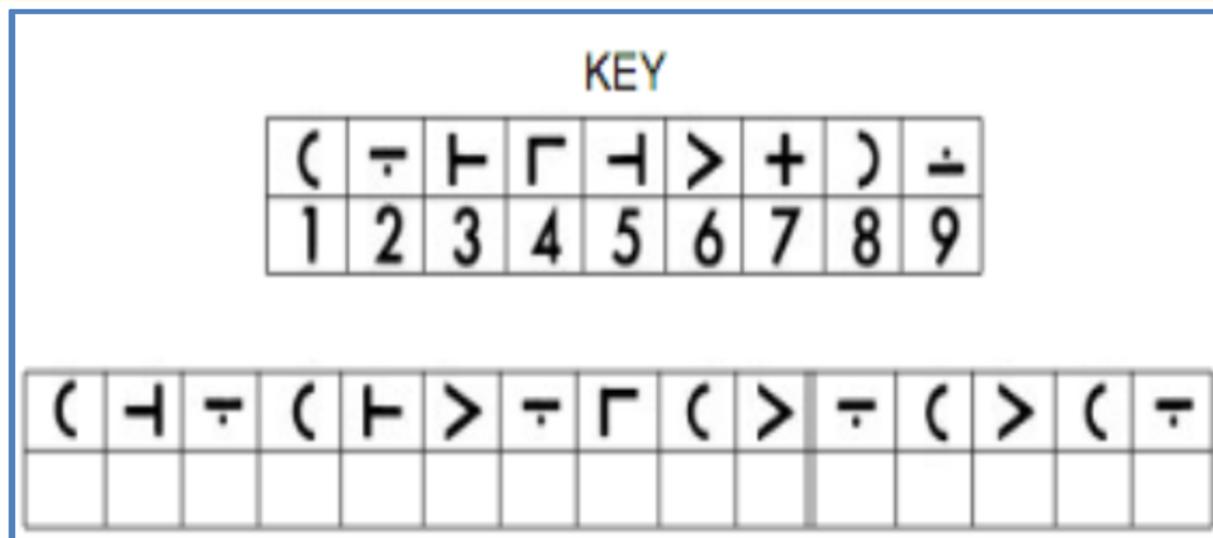


Figure 1: Example of the key sequence and first line of the Symbol Digit Modalities Test. Sample material from the SDMT copyright © 1973 by Western Psychological Services.

Statistical analysis

Breath analyzers usually do not distinguish one individual from another because they are programmed to assume that test subjects share the same traits. Such “averaging” can result in inaccurate readings. The speed at which people absorb, distribute, and metabolize alcohol varies as much as three or four times between individuals [1,12,13]. In addition, environmental factors, including the presence of products such as paint, thinner, glue, and gasoline, the subject’s diet, its body mass index as well as its living circumstances and its genetic design of the metabolism capacity in the liver can also skew breath test results. In order to eliminate these disadvantages, the individual relative difference of the exhaled alcohol (delta BAC in ppm) after getting from an intoxicated state to a state of relative intoxication following the addition of the Q10 formulation. This was used for calculation to demonstrate an overall effect giving the breath tests as much accuracy as possible to detect differences and calculate the possible faster turnover of the toxin.

To evaluate statistically significant difference between the two-phase trials and their effect on BAC as well as on the mental performance (STMD)-Test, the two tailed Wilcoxon matched-pairs signed rank test was used. In addition, a correlation analysis was done using the least square fit for the mean of BAC- and their corresponding STMD-values in order to see to what extend the expired alcohol concentration affected mental concentration and if the addition of Q10 resulted in a better performance when compared to the control phase. A statistical value of $p < 0.05$ was considered as significant.

Results

The use of the Q10 formulation did result in a highly significant reduction of the exhaled breath alcohol content when Q10 was given on top the alcohol beverages a result of which induced a mean reduction 0.18 ppm when compared to the time of not adding any Q10 (Table 1). In addition, this beneficial effect was also seen in all subjects performing the neurocognitive test (SDMT) taken at different end-points, implying that the cerebral capacity to handle this seemingly easy test under pressure war significantly impaired following alcohol ingestion when compared to control ($p < 0.001$). The characteristics of alcohol resulting in a reduced mental capacity to handle complex tasks

and blocking the action of circuits within the brain was partially reinstated by giving the subjects a Q10 formulation, which only thereafter resulted in a recovery of mental performance by a significant factor of $p < 0.005$, when compared to the phase without Q10 (Figure 2). This latter effect is nicely underlined by demonstrating the close interrelation of alcohol content in the expired air with a decline and the partial recovery of a higher mental performance, using the Symbol Digit Modalities Test. This can be seen in figure 3, where the high correlation of BAC with the corresponding STMD data results in a near ideal fit with an $r^2 = 0.98$ and a p-value of < 0.004 . This underlines the notion of a close interaction of alcohol concentration and the inability to execute higher mental tasks.

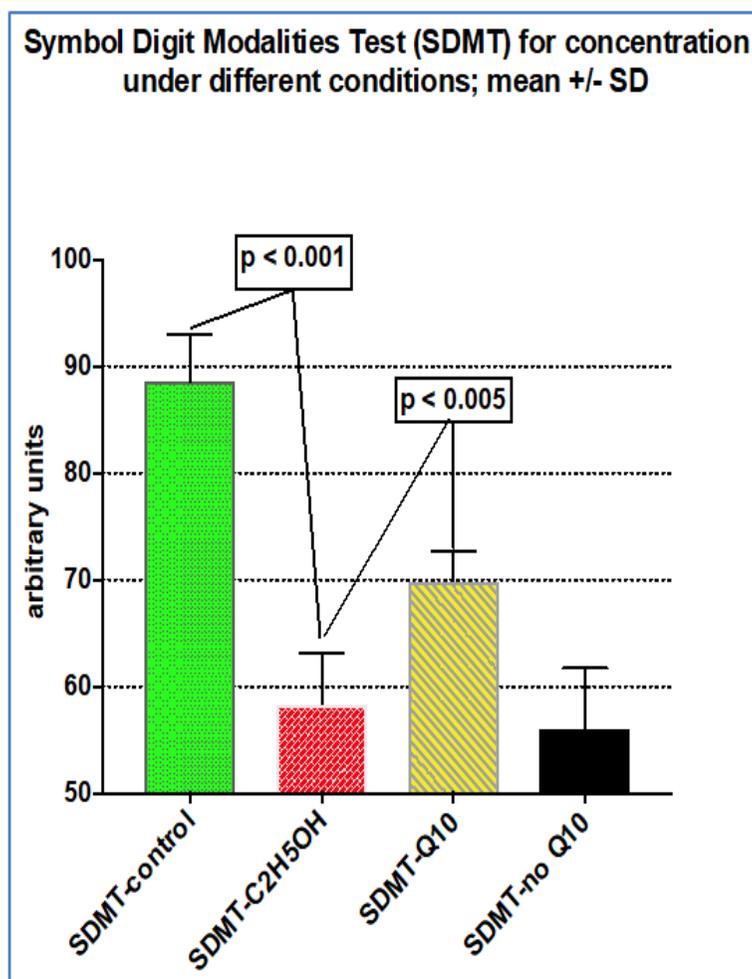


Figure 2: The Symbol Digit Modalities Test (SDMT)-values depicting the neurocognitive capabilities of subjects before and after the alcohol intake, with or without the addition of the Q10 formulation Greenspeed® after a period of 60 min ($n = 12$; mean \pm SD). Note the highly significant decline in cognitive function ($p < 0.001$) could be partially restored by the additional intake of the Q10 formulation ($p < 0.005$).

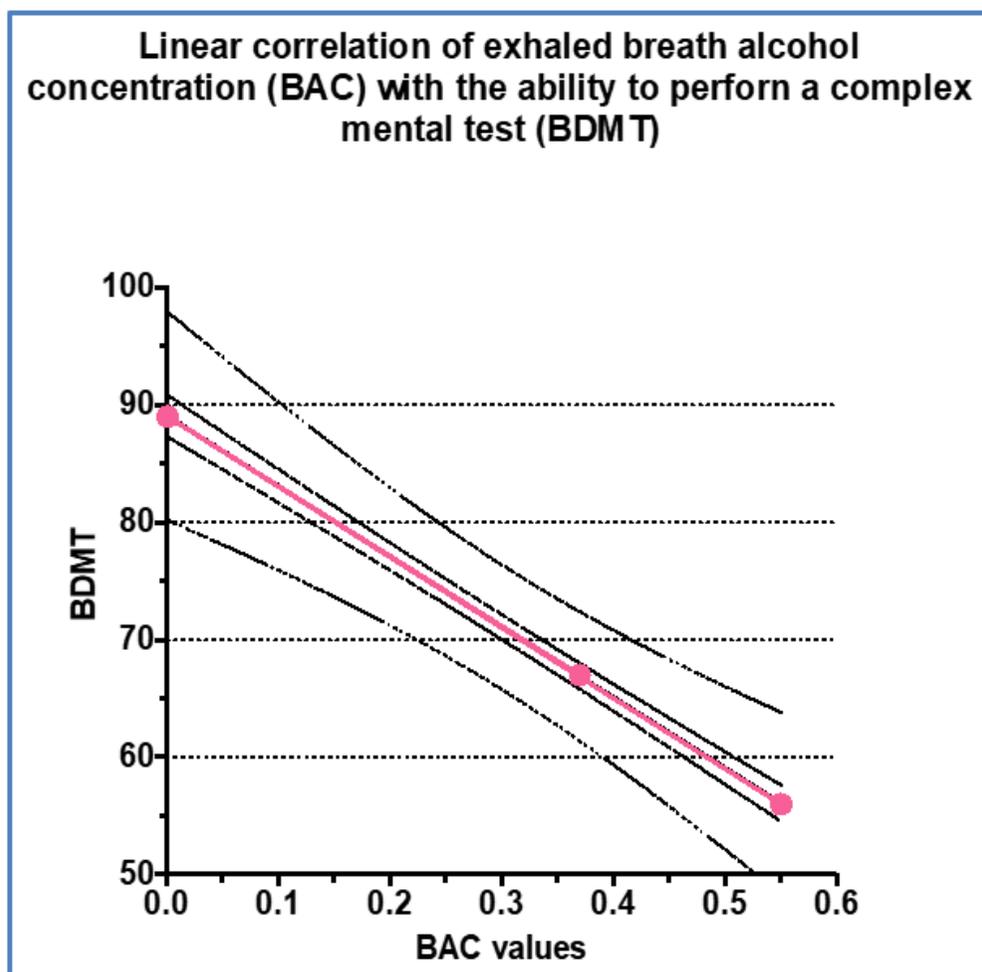


Figure 3: Linear correlation and their corresponding 95% and 99% confidence bands of the mean difference of exhaled alcohol concentration and the mental capacity in twelve volunteers following ingestion of alcohol and its partial recovery with Q10.

Demographic data of subjects	Age (years) 54 ± 8.2	Weight (kg) 86 ± 16	Hight (cm) 178 ± 4.5	Male/female 12/00
Control BAC 0.0	After C_2H_5OH 0.55 ± 0.4	plus Q10 $0.073 \pm 0.15^{**}$	no Q10 0.57 ± 0.1	Delta BAC 0.48 ± 0.09

Table 1: Demographic data of subject participating in the study and their respective BAC (breath alcohol concentration) before, and after alcohol ingestion, followed with or without the addition of the Q10 formulation. Delta BAC reflects the mean of all individual's difference of exhaled alcohol content (ppm) followed by Q10 administration within one hour (mean \pm SD; $^{**}p < 0.005$).

Discussion and Conclusion

In order for the alcohol to become inactive and having lesser depressive effect on the CNS is its metabolization pathways within the liver where the bulk of alcohol metabolism takes place [14]. Some alcohol metabolism also occurs in other tissues, including the pancreas

[15] and the brain, causing damage to cells and tissues [1]. The most common of these metabolic pathways involves two enzymes. First, ADH metabolizes alcohol to acetaldehyde, a highly toxic substance and a known carcinogen [12]. Then, in a second step, acetaldehyde is further metabolized down to another, less active byproduct called acetate [12], which then is broken down into water and carbon dioxide for easy elimination [13]. All this takes place in liver cells in which the enzymes cytochrome P450 2E1 (CYP2E1) and catalase also break down alcohol to acetaldehyde. However, CYP2E1 only is active after a person has consumed large amounts of alcohol, and catalase metabolizes only a small fraction of alcohol in the body [12].

Research shows that alcohol use and alcohol-related problems are influenced by individual variations in alcohol metabolism, or the way in which alcohol is broken down and eliminated by the body. Since alcohol metabolism is controlled by genetic factors, such as variations in the enzymes that break down alcohol. Also, environmental factors, such as the amount of alcohol an individual consumes and his or her overall body mass do play a significant role. This is underlined by the present study where the higher the body mass index it resulted in a lesser likelihood that the alcohol content induced a significant impairment of coordination, or loss of good judgment [14,15]. However, most of all a reduction in the neurocognitive capabilities as demonstrated in the present SDMT was accompanied with a slurred speech, an impaired balance and vision, reflecting that not thinking straight may put people at a great risk for alcohol problems. Such potential risks however can be reduced or even eliminated once the metabolic breakdown is increased as demonstrated in our set of volunteers. Our study results outlines that the breakdown of alcohol can be boosted by adding a Q10 formulation with high bioavailability [6], resulting in a beneficial faster decline of the expired alcohol concentration. Such effect can readily be explained by the action of Q10 within the electrical transport chain of mitochondria within the liver as well as the brain cells, being the prime driver in the generation of adenosine triphosphate or for short ATP [16], a necessary constituent for any kind of cell function. As such it is plausible to suggest that the addition of the Q10 formulation resulted in a higher alcohol turnover through those enzymes necessary to breakdown this potential toxin, i.e. alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH), while at the same time also being a protective agent against organ cell toxicity [17]. Since these enzymes present the necessary tools to break apart the alcohol molecule, and making it possible to eliminate it from the body [12], it is conceivable that the faster decline in the breath alcohol concentration in the subjects taking the Q10 supplement is the result of an increase in the higher rate of the alcohol turnover. But most of all its important to mention, the most significant effect was seen in the Symbol Digit Modalities Test within all subjects resulting in a higher scoring when compared to the correlation control situation without Q10. Such effect is further underlined by the close correlation of the exhaled alcohol content and the ability to perform a mentally demanding test. Linear correlation analysis also shows that the lower the alcohol content the better mental performance while the exhaled alcohol concentration closely seems to mirrors the blood concentration from where the liver detoxifies any kind of foreign substance [18].

While acetaldehyde may be the most important metabolic breakdown product affecting the brain, other researchers argue that acetaldehyde concentrations in the brain are not high enough to produce these effects [19]. This is because the brain has a unique barrier of cells (the blood-brain barrier) that help to protect it from toxic products circulating in the bloodstream. It however, is possible, that acetaldehyde may be produced in the brain itself when alcohol is metabolized by the enzymes catalase [20,21] and CYP2E1 [22]. And since Q10 also nourishes brain cells to be more productive, a fact which had been clearly demonstrated in a previous study with Q10 measuring higher mental capabilities like focused attention [6]; the mode of action on our intoxicated subjects therefore may be twofold. First within the liver there is a higher turnover of alcohol, and second within the brain tissue itself, both of which do result in a reduction of toxic metabolites of alcohol affecting mental performance.

The latter is underlined by the close correlation of the expired alcohol content and higher mental functions, which corroborates the justified use of the breath alcohol content as a predictive and reliable tool to demonstrate mentally incapacitating effects of the toxin alcohol. It remains to be seen if the effects of alcohol on the brain, as seen in our set of subjects, can even be reduced further once higher dosages of Q10 are used or when an additional intake of Q10 such as the next morning, may reduce the commonly observed hang-over

effects. Many late-night revelers never think about the time it takes to sober up affecting driving or performing safety sensitive duties on the morning thereafter and which can put anyone at risk. For instance, if an individual's breath alcohol content (BAC) is 0.5 after an evening of heavy drinking at 1:00 a.m., they may not be under the legal driving limit of 0.08 BAC until approximately 9:00 a.m. later that morning. One may imagine how long it might take for the individual to be under the Department of Transportation's BAC limit of 0.2 ppm when starting off with an exhaled alcohol content of 0.5 ppm at the evening. Therefore, an additional intake of Q10 on the next morning might result in a further decline of alcohol concentrations which then may be deemed safe enough to officially operate a motor vehicle.

In summary, the present study in middle-aged volunteers consuming excessive amounts of alcoholic beverages not only demonstrated marked deleterious effects on mental performance, such as found in the Symbol Digit Modalities Test. The study also clearly demonstrates that the addition of the Q10 formulation resulted in a faster decline of alcohol content being due to a higher metabolic turnover within the liver as well as brain cells. And although no enzyme concentration were measured in our subjects it's fair to speculate that an increase in the synthesis of enzymes is due to a higher ATP formation as demonstrated elsewhere [6]. While this speculative mode of action does present a plausible explanation, it however should be followed up in a future study.

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