

The effects of a post-workout nutraceutical drink on body composition, performance and hormonal and biochemical responses in Division I college football players

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Abstract

Football players walk a fine line between optimal training and overtraining. Manipulating nutrient intake has the potential to maximize the biochemical environment necessary to induce peak performance and proper recovery. The purpose of this study was to examine the impact of supplementing the diet of Division I football players with a proprietary nutraceutical recovery drink on changes in performance, body composition, anabolic status, muscle damage, inflammation and oxidative stress over the course of a 7-week conditioning period immediately prior to preseason camp. At the beginning (trial 1) and end (trial 2) of a 7-week training phase, body composition, vertical jump and 225 lb bench press were assessed in Division I college football players ($n = 25$). A 30 s Wingate Anaerobic Test plus eight 10 s intervals was used to examine power and biochemical responses. Blood samples were collected pre-, 0 and 60 min post-test for analysis of interleukin-6 (IL), 8-isoprostane (8-iso), cortisol (CORT) and resting testosterone:CORT (T:C) ratios. Athletes were randomly assigned to either an experimental group (EXP) receiving the nutraceutical drink ($n = 13$) or a control group (CON) receiving an isocaloric equivalent ($n = 12$). EXP had a significantly greater increase in peak power ($P < 0.05$) and significant decreases in percentage body fat and fat mass ($P < 0.05$). Multivariate ANOVA for repeated measures (RM MANOVA) revealed a significant test \times time \times group interaction ($P < 0.05$) for changes in CORT, IL-6 and 8-iso from trial 1 to trial 2. Follow-ups revealed no significant differences between groups at trial 1 for any of the variables. At trial 2, EXP had significantly lower CORT at rest ($P = 0.01$) and 60 min post-test ($P = 0.001$). Additionally, IL-6 was significantly different between EXP and CON at 0 ($P < 0.01$) and 60 min post-test ($P < 0.01$), with CON having an elevated IL-6 response. There were also differences in both 8-iso and creatine kinase at all time points at trial 2, with CON having higher levels ($P < 0.02$). There were significant differences between groups in T:C ratio changes ($P < 0.05$), with EXP having an improved T:C ratio. It appears that supplementing the post-workout diet of Division I college football players with a nutraceutical recovery drink has favourable effects on body composition, peak power output and biochemical markers. Based on differences between groups that emerged at rest at trial 2, it appears that this supplement positively impacts both acute and chronic physiological responses indicative of improved recovery.

Keywords: antioxidant; ergogenic aids; anaerobic power; oxidative stress; hypothalamic–pituitary–adrenal axis; superoxide dismutase

Introduction

Preparatory-phase workouts serve to condition the athlete for the pending season and ready them for the training and competitions that their sport demands while trying to avoid inducing overtraining syndrome. As predominantly anaerobic athletes, football players are looking to utilize their preseason training to maximize both power and strength. This is partially accomplished through increasing lean body mass (LBM) while simultaneously minimizing any accompanying gains in (or reducing) fat mass (FM). In order to accomplish this task, the athletes must have a positive protein turnover and attain a net anabolic state. Under intense training conditions and without proper nutrition, college football players run the risk of experiencing an increase in the catabolic environment that can result from insufficient recovery, thus limiting performance gains.

Of the physiological markers studied in anaerobic athletes, the hormones cortisol (CORT) and testosterone (TEST) are useful indicators of catabolism and anabolism, respectively. CORT is released following varying stressors such as an intense, acute exercise bout. Prolonged elevation of this catabolic hormone is indicative of chronic stress and can, in part, lead to overtraining and decreased performance¹. TEST, on the other hand, is an anabolic hormone that plays a key role in the tissue-building process, which is a pivotal aspect of any anaerobic training plan. When TEST is low, an athlete will not recover as rapidly and the training load will typically need to be reduced in order to prevent overtraining. Perhaps, more important than either one of these hormones alone is the ratio of TEST to CORT (T:C). The T:C ratio is an indication of the net anabolic status within the body^{2,3}. It appears that the T:C ratio is a key indicator of the chronic physiological strain of the training programme³. In addition to the T:C ratio, research has begun to consider exploring the use of oxidative stress and various inflammatory markers to track the breakdown of muscle tissue and the ensuing recovery process following exercise.

Structural damage to the muscle fibre is a consequence of high-intensity training.

Calcium, myoglobin, troponin-I and creatine kinase (CK) are all contractile elements whose appearance in the periphery has been found to be related to minute tears in the muscle tissue⁴. Of these markers, CK is commonly employed as an indicator of muscle breakdown or membrane disruption⁵.

Cytokines, specifically interleukin-6 (IL-6), have been proposed to mediate several of the body's physiological responses to exercise⁶. IL-6 is believed to play an important role in triggering the acute immune response due to exercise-induced muscle injury⁷.

Also, IL-6 exhibits a graded response to exercise intensity and will further be enhanced when glycogen stores are being used^{6,8}. This implies that repeated high-intensity anaerobic exercise would result in a greater secretion of IL-6.

Performing high-intensity workouts that are near maximal capacity can result in increased oxidative stress^{9,10}. While reactive oxygen species are a natural reaction by-product of cellular respiration, their formation increases as the intensity of exercise increases^{9,10}. Oxidative stress has been linked to muscle damage, fatigue and lipid peroxidation, all of which can delay muscle recovery and negatively affect performance^{9,10}. The high stress of anaerobic exercise is sufficient enough to overload the body with free radicals brought about by oxidative stress¹¹. Supplementation with antioxidants has been investigated to determine their impact on oxidative stress. Though an increased need for antioxidants is evident as exercise intensity increases, very little attention has been focused on the anaerobic athlete and performance¹⁰. An alternative to antioxidant supplementation is enhancement of endogenous antioxidant capacity through positive changes in the antioxidant enzymes glutathione peroxidase and superoxide dismutase (SOD)^{12,13}. Recent research has suggested that direct supplementation with SOD may be highly effective at combating oxidative stress and enhancing endogenous resources.

The SOD (Glisodin[®]) found in the blend tested in this study is unique, in that it is the first commercially available source of absorbable SOD¹⁴. Research using this form of SOD has demonstrated antioxidant and anti-inflammatory properties^{15,16}. This oral form of SOD is part of a proprietary antioxidant/anti-catabolic nutraceutical mixture that has been incorporated into dietary supplements (Resurgex[®] and Resurgex Plus[®]) that were developed to improve immune functioning, spare lean muscle and reduce oxidative stress in patients suffering from muscle-wasting diseases. A recent study using Resurgex[®] demonstrated performance enhancement through an attenuated lactate response, increased time to fatigue and reduced resting CK levels in collegiate soccer players¹⁷. However, no research has been published on performance and biochemical effects in the anaerobic athlete.

The purpose of this study is to examine the impact of supplementing the diet of Division I football players with a proprietary recovery drink and nutraceutical blend on changes in performance, LBM, anabolic status, muscle damage, inflammation and oxidative stress over the course of a 7-week conditioning period immediately prior to preseason camp. It is hypothesized that off-season training in college football players will result in improvements in fitness, body composition and anabolic profile, and that

supplementing with Resurgex Fusion[®] will enhance these effects compared with an isocaloric control. It is also hypothesized that those athletes receiving Resurgex Fusion[®] will demonstrate lower oxidative stress, inflammation and muscle damage compared with an isocaloric control in response to a maximal anaerobic exercise test.

Methods

Subjects

Members ($n = 25$; $M_{\text{weight}} = 112.5 \pm 4.1$ kg; $M_{\%BF} = 19.9 \pm 7.2\%$) of a Division I college football team were asked to participate in the study. Risks and benefits were explained to the subjects and each of them gave written informed consent prior to participation in the study. All athletes must have been free from current injuries limiting their ability to train and complete physiological testing as determined by the Rutgers University Sports Medicine staff. Athletes with reported wheat allergies were excluded due to the gliadin polymer used in the SOD component of the experimental supplement.

Study design and supplementation

Performance tests were administered over two separate consecutive days both at the beginning (trial 1) and end (trial 2) of summer conditioning leading up to preseason camp. Trials 1 and 2 were separated by 7 weeks and consisted of a structured workout regimen guided by the football strength staff. Following trial 1, the athletes were matched on playing position and LBM and randomly assigned to either EXP receiving Resurgex Fusion[®] (Millennium Biotechnologies Inc., Basking Ridge, NJ, USA) or CON receiving an isocaloric equivalent (Gatorade Nutrition Shakes[®]) without the proprietary nutraceutical blend (see Table 1). The formulation is similar to that used

Table 1 Comparison of the nutrient content of CON versus EXP recovery drinks per serving

	Control (Gatorade Nutrition Shake [®])	Experimental (Resurgex Fusion [®])
Volume (ml)	325	325
Calories (kcal)	368	354
Carbohydrate (g)	54	56
Protein (g)	20	20
Fat (g)	8	5.5
Nutraceutical blend		
CoQ10 (mg)	0	75
SOD/gliadin	0	500
Nucleotides (mg)	0	300
D-Ibose (mg)	0	1000
βGlucans (mg)	0	200
Hi OROC Vita Berry Blend (mg)	0	150
Fructo-oligosaccharide (mg)	0	200

in a previous study on collegiate soccer players¹⁷ with macronutrient ratios modified for optimal performance and ingredients tailored to recent NCAA regulations. In order to keep the athletes blind to the group assignment, the drinks were premixed and administered daily in generic, unlabelled bottles by the research team. The researchers administered the drinks and monitored consumption compliance daily after workout sessions in the football training facility. A 3-day dietary recall log was used for each subject prior to each trial and analysed using commercially available dietary analysis software (FoodWorks, Xyris Software, Highgate Hill, QL, Australia). The 3-day duration of dietary recall has previously been validated to accurately portray reliable energy and nutrient consumption data¹⁸. After accounting for supplement nutrient profiles, there were no significant differences between groups in nutrient and caloric consumption (all $P > 0.50$).

At the first testing day of each trial, subjects were tested for anaerobic power (vertical jump (VJ)) and muscular endurance (225 lb bench press (BP) for reps). At the second day of each trial, athletes had body composition assessed and blood samples were obtained before, immediately after and 1 h after a Wingate Anaerobic Test (WAnT)¹⁹ for later analysis of oxidative stress markers (8-isoprostane (8-iso) PGF_{2α}, muscle breakdown (CK)), hypothalamic-pituitary-adrenal (HPA) axis activation (CORT) and inflammatory cytokine (IL-6). Pre-test serum samples were used to assess resting TEST:CORT (T:C) ratios. Athletes were required to refrain from training for 18–24 h prior to each test, and each athlete was tested at the same time of day for each trial to control for diurnal variations.

Exercise test procedures

For each testing day, all athletes reported to the Rutgers University Human Performance Laboratory. Verbal confirmation assured that athletes arrived for testing normally hydrated, having eaten a high-carbohydrate meal provided as part of their training table approximately 2–3 h prior, and refrained from ingesting substances that could affect normal physiological functioning (i.e. tea, coffee, alcohol and nicotine). The design of the provided meals was based on the standard USDA macronutrient design that consists of 55–60% carbohydrate, 15–20% protein and 20–30% fat. On the first testing session of each trial, the athletes completed a 15–20 min warm-up consisting of a general systemic warm-up followed by a dynamic range of motion exercises before being tested on VJ followed by the BP. VJ was assessed using a Vertec measuring device (Sports Imports, Columbus, OH, USA). Subjects completed three efforts with 60–90 s rest following each trial. The highest of the three

jumps was recorded. After completing the VJ, the athletes then completed a standard upper body muscular endurance test for football players (the 225 lb BP for reps). After two to three warm-up sets, the subjects were given a 4–5 min rest before attempting the test. The score consisted of the total number of repetitions completed in good form before momentary muscular failure. On the second day of testing, body composition was assessed using air displacement plethysmography (i.e. BOD POD, Life Measurement, Inc., Concord, CA, USA). Following this, each athlete rested in a supine position for 10 min before commencing with the pre-test blood draw. Blood samples were also obtained immediately following completion of the exercise test and at 60 min post-test with the subject in a supine position.

Subjects performed the WAnT protocol on the second testing day of trial 1 and trial 2 on a Monark 894E Anaerobic Test Ergometer (Monark Exercise AB, Vansbro, Sweden). The load was set according to each subject's weight²⁰. The test consisted of a 30 s WAnT followed by 5 min of rest and then eight 10 s intervals using the same load. Each interval was separated by 2 min of rest. The resistance was set at 0.075 kp kg^{-1} body weight.

Performance measures

Peak power during the WAnT was defined as the highest mechanical power output elicited during each 30 s test. Mean power was calculated based on the average mechanical power produced during the test. Maximal VJ height was used to establish power and the number of repetitions completed for the 225 lb BP-constituted scores for muscular endurance.

Body composition

Percentage body fat (%BF) was calculated through a two-stage procedure. Body volume was measured *via* air displacement plethysmography using the BOD POD (Life Measurement, Inc.), as described in previous literature²¹. Using the BOD POD, the error of body volume reading is roughly 0.02%, which allows for calculation of %BF with only 0.01% error²¹. In addition to %BF, LBM and FM were also calculated. Height and weight were recorded in conjunction with body composition assessment.

Biochemical measures

Before, immediately after and 60 min after each WAnT + intervals test, blood samples were collected *via* an indwelling cannula inserted into an antecubital vein using a vacutainer system (Becton Dickinson, Rutherford, NJ, USA). Approximately 10 ml were collected in a serum separator tube and 10 ml in an EDTA-coated tube. After removing a 1 ml aliquot of whole blood for haemoglobin and haematocrit analysis

in order to correct for plasma volume changes, plasma for 8-iso assays was obtained by centrifugation of whole blood in the EDTA tubes at $3000 \times g$ for 10 min at 4°C . The serum separator tubes were left to stand for 30 min to facilitate clotting before being centrifuged at $3500 \times g$ for 15 min at 4°C in order to obtain serum for CK, IL-6, TEST and CORT analysis. Aliquots of blood, serum and plasma were placed in microvials and stored at -80°C until analysis of the dependent measures. The storage tubes for 8-iso were pre-coated with $200 \mu\text{g}$ butylated hydroxy-toluene. All assays were performed in duplicate.

IL-6 was determined *via* ELISA using a commercial kit (IBL, Hamburg, Germany). Serum CK was analysed using a CK/NAC kinetic assay (Stanbio Laboratory, Boerne, TX, USA). Serum TEST and CORT were analysed using RIA (MP Biomedicals, Irvine, CA, USA).

In order to analyse plasma-free 8-iso $\text{PGF}_{2\alpha}$, plasma from the EDTA tubes was first purified by diluting the sample in a 1:5 ratio with Eicosanoid Affinity Column Buffer (Cayman Chemical, Ann Arbor, MI, USA). A known amount of tritiated 8-iso $\text{PGF}_{2\alpha}$ was added prior to purification in order to determine recovery rates. Ethanol was added to the solution and the sample was chilled at 4°C for 5 min to precipitate proteins, and then centrifuged at $1500 \times g$ for 10 min at 4°C . The supernatant was decanted and the remaining ethanol evaporated under a nitrogen stream. The pH was then lowered to 4.0 using drop-wise addition of HCl. Samples were then passed through a C-18 affinity column (Cayman Chemical) previously activated with methanol and ultra-pure water. Following addition of the sample, the column was washed with 5 ml ultra-pure water followed by 5 ml HPLC-grade hexane (Sigma Chemical, St Louis, MO, USA). The sample was then eluted with 5 ml of an ethyl acetate-methanol solution (Cayman Chemical). The elution solution solvents were evaporated again under nitrogen, and the samples were then reconstituted in $450 \mu\text{l}$ EIA buffer (Cayman Chemical). For each purified sample, $50 \mu\text{l}$ were analysed using a commercially available 8-iso EIA kit (Cayman Chemical), with each sample assayed in duplicate. Absorbance values were determined with a SpectraMax 340 microplate reader (Molecular Devices, Sunnyvale, CA, USA) between 405 and 420 nm and the raw data corrected using the recovery rates of tritiated $\text{PGF}_{2\alpha}$.

Statistical analysis

Separate MANOVAs were used to assess effects of training and supplementation on changes in performance variables (WAnT peak power, WAnT average power, VJ and BP) as well as changes in body composition variables (%BF, LBM and FM).

Significant multivariate effects were followed by univariate follow-up tests.

A $2 \times 3 \times 2$ (trial \times time \times group) MANOVA with repeated measures on the first two factors was conducted to assess the effects of training and supplementation on CORT, IL-6, 8-iso and CK. Univariate follow-up tests for each variable were conducted in the event of a significant multivariate effect. Simple effects of group within time were used to compare EXP and CON responses at each time point at each trial. A separate 2×2 (group \times trial) RM ANOVA was used to examine differences in T:C ratio. Simple effects of trial within group were used to examine changes for EXP and CON.

Effect sizes (ES) were calculated to compare magnitude of changes in the EXP and CON groups using Hedges' g formula for ES computation. This ES computation was used for all variables. Group data are expressed as mean \pm SD and statistical significance was set at the $P < 0.05$ level. Analyses were conducted using the SPSS 16.0 statistical program.

Results

Performance

MANOVA revealed significant group differences for changes in performance from trial 1 to trial 2 ($P = 0.008$). Univariate follow-ups indicated that there were significant differences between EXP and CON for changes in peak power ($P = 0.021$) and VJ ($P = 0.016$). For EXP, peak power increased significantly from trial 1 to trial 2 ($1.9 \pm 0.5 \text{ W kg}^{-1}$, ES = 0.96, $P < 0.001$; See Fig. 1), but there was no change in VJ ($-0.1 \pm 0.6 \text{ cm}$, ES = 0.0, $P = 0.88$). For CON, there was no change in peak power ($0.1 \pm 0.5 \text{ W kg}^{-1}$, ES = 0.14, $P = 0.68$), but there was a significant decrease in VJ ($-2.5 \pm 0.7 \text{ cm}$, ES = -0.2 , $P = 0.012$). There were no differences

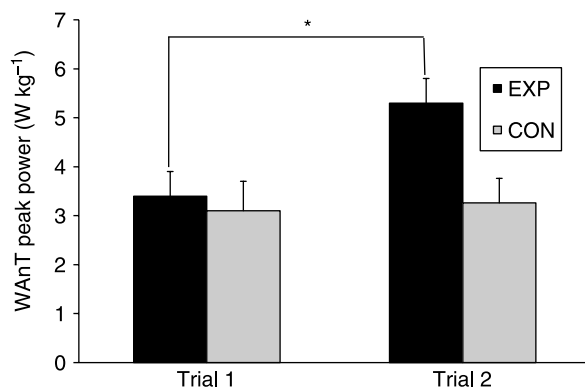


Fig. 1 Wingate Anaerobic Test peak power output at trial 1 and trial 2 for experimental (EXP) versus control (CON). Data (mean \pm SE) are expressed as W kg^{-1} . Peak power significantly increased from trial 1 to trial 2 in the EXP group. * represents $P < 0.001$ difference from baseline within condition

found between the treatment groups for BP repetitions ($P = 0.712$) and average power ($P = 0.967$).

Body composition

The EXP ($0.66 \pm 0.25 \text{ kg}$) and CON ($0.75 \pm 0.45 \text{ kg}$) groups had similar increases in LBM ($P = 0.84$). However, this change was only significant for the EXP group from trial 1 to trial 2 ($P = 0.021$, ES = 0.7). There were significant differences between groups for changes in %BF ($P = 0.031$) and FM ($P = 0.031$). EXP had a decrease in both %BF ($-0.8 \pm 0.4\%$, ES = -0.1) and FM ($-1.0 \pm 0.6 \text{ kg}$, ES = -0.95), while CON demonstrated an increase in both %BF ($0.6 \pm 0.4\%$, ES = 0.1) and FM ($0.9 \pm 0.6 \text{ kg}$, ES = 0.89).

Hormonal and biochemical responses

There was a significant multivariate test \times time \times group interaction ($P = 0.011$) for CORT, IL-6, 8-iso and CK. Follow-ups indicated significant test \times group interactions for CORT ($P = 0.023$), IL-6 ($P = 0.013$), 8-iso ($P < 0.001$) and CK ($P = 0.001$). There was also a significant test \times time \times group interaction for both CORT ($P = 0.042$) and IL-6 ($P = 0.01$).

Simple effects of group within time for both trial 1 and trial 2 revealed that there were no significant differences between EXP and CON for any of the variables at trial 1 ($P > 0.08$). At trial 2, however, a number of significant differences emerged between groups. For CORT, there were significant differences between EXP and CON at rest ($P = 0.01$; ES = -1.12) and at 60 min post-test ($P = 0.001$; ES = -1.55), with EXP having lower CORT at both time points (see Fig. 2). The response immediately post-exercise was not different ($P = 0.59$; ES = -0.23). For IL-6, there were significant

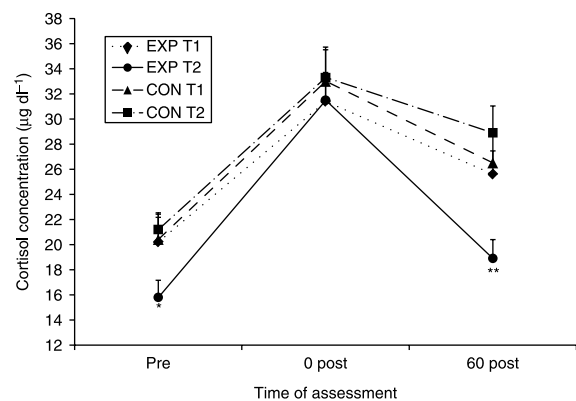


Fig. 2 Cortisol concentration pre-, 0 (0 post) and 60 min post-test (60 post) at trial 1 (T1) and trial 2 (T2) for experimental (EXP) versus control (CON). Data (mean \pm SE) are expressed as $\mu\text{g dl}^{-1}$. EXP had lower cortisol secretion compared with CON at both pre-test and 60 min post-test at trial 2. * represents $P < 0.05$ difference between conditions within time; ** represents $P < 0.01$ difference between conditions within time

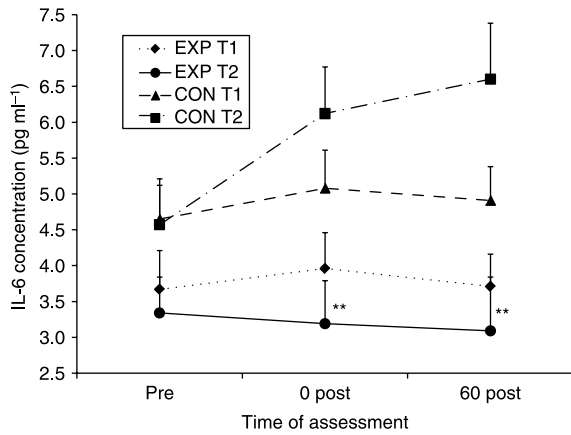


Fig. 3 Interleukin-6 production pre-, 0 (0 post) and 60 min post-test (60 post) at trial 1 (T1) and trial 2 (T2) for experimental (EXP) versus control (CON). Data (mean \pm SE) are expressed as pg ml^{-1} . EXP had significantly lower IL-6 levels at 0 and 60 min post-test compared with CON at trial 2. ** represents $P < 0.005$ difference between conditions within time

differences between EXP and CON at 0 ($P = 0.003$; $ES = 1.3$) and 60 min ($P = 0.004$; $ES = 1.3$) post-test (see Fig. 3). CON had significantly higher 8-iso responses at all time points compared with EXP (pre-test: $P = 0.008$, $ES = 1.16$; 0 min post-test: $P = 0.006$, $ES = 1.2$; 60 min post-test: $P = 0.016$, $ES = 1.04$; see Fig. 4). Differences in CK responses emerged between EXP and CON at all time points, with CON having higher CK values (pre-test: $P = 0.017$, $ES = 1.03$; 0 min post-test: $P = 0.02$, $ES = 1.0$; 60 min post-test: $P = 0.014$, $ES = 1.06$).

Results of the RM ANOVA revealed a group \times time interaction for T:C ratio ($P = 0.029$). From trial 1 to trial 2, EXP improved T:C ratio (trial 1: 0.25 ± 0.02 ; trial 2: 0.31 ± 0.03 ; $ES = 0.72$), while CON had

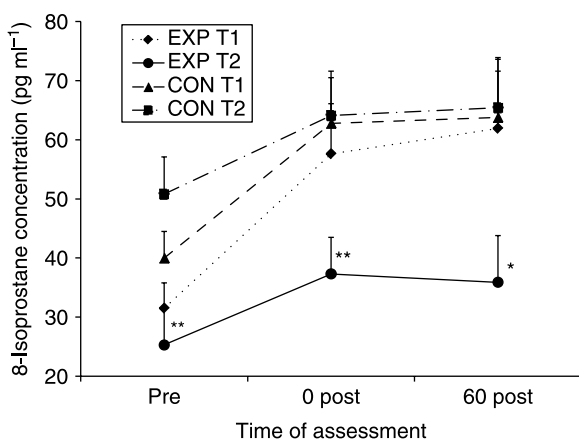


Fig. 4 8-Isoprostane levels pre-, 0 (0 post) and 60 min post-test (60 post) at trial 1 (T1) and trial 2 (T2) for experimental (EXP) versus control (CON). Data (mean \pm SE) are expressed as pg ml^{-1} . At trial 2, CON had significantly higher 8-isoprostane levels at pre-, 0 and 60 min post-test compared with EXP. * represents $P < 0.05$ difference between conditions within time; ** represents $P < 0.01$ difference between conditions within time

a reduction in T:C ratio (trial 1: 0.23 ± 0.03 ; trial 2: 0.20 ± 0.02 ; $ES = -0.3$).

Discussion

It appears that supplementing the post-workout diet of Division I college football players with a protein, carbohydrate and nutraceutical recovery drink has favourable effects on body composition, peak power output and biochemical markers. Results revealed that the EXP had significantly greater improvements in peak power, %BF, FM, T:C ratio, inflammation and HPA recovery. Throughout the 7-week training period, both groups were actively conditioning for the upcoming football preseason. LBM improvements were seen in both groups. However, CON gained FM and increased %BF, while EXP showed decreases in both variables. The resultant changes in FM and %BF may be indicative of an enhanced anabolic environment in EXP, particularly considering the differences in the T:C ratios between the two groups. EXP had a significantly improved T:C ratio at trial 2, which implies that they were in an anabolic state. On the other hand, CON actually saw a decrease in their T:C ratio at trial 2 compared with trial 1, suggesting a potentially more catabolic state. A quicker return to an anabolic state was supported by a faster acute HPA recovery in EXP following interval testing as well.

The CORT response in both groups was similar immediately following the WANt + intervals at trial 1. However, by the end of 7 weeks of training and supplementation, at 60 min post-exercise, there was a significant improvement in CORT clearance for EXP compared with CON. It is important to note that the enhanced HPA recovery occurred despite similar CORT responses immediately following the WANt + intervals. This indicates similar stressor intensity across the groups and also suggests that supplementation did not interfere with the ability to maximally engage HPA response to allow for peak performance. This enhanced HPA axis recuperation could offer an explanation for the improved performance and body composition. The reduced time spent in a net catabolic state post-exercise could also be partially responsible for the greater power at trial 2 for EXP. Lastly, the enhanced ability to reduce CORT concentration following exercise may impact the suppression of the immune response associated with glucocorticoids²².

The enhanced recovery seen in the EXP may have been responsible for reducing the severity of muscle breakdown at the conclusion of the 7-week training cycle. The attenuated plasma CK levels of the EXP at all time points during trial 2 may be explained through some protective functions provided by the supplement in terms of membrane stability. During intense exercise, muscle cell membranes are subject

to damage and microtears, which may allow for the leakage of CK and other cytosolic and myofibrillar proteins. Additionally, the actions of neutrophils may mediate the release of this and other cytosolic enzymes due to ruptures they caused in the membranes²³. Additionally, any reduction in oxidative damage as a result of the antioxidant blend in the supplement may act to retain the continuity of the sarcolemma. This bolstering effect on the cell's integrity may help to minimize or eliminate the occurrence of delayed onset muscle soreness. As has previously been discussed, evidence of excess-free radical production in the body can be associated with impaired immune function, soreness, fatigue and injury²⁴. It is notable that 8-iso levels were lower even at baseline at trial 2 for EXP, suggesting chronic reductions in oxidative stress²⁵. Additionally, the 8-iso response was further attenuated in EXP following the WAnT + intervals. This response would facilitate improved recovery between training sessions, improved membrane function and stability, and potentially adaptive functioning of the HPA axis given the established link between oxidative stress and CORT secretion¹⁷. The attenuated 'stress response' was further reflected in the cytokine (IL-6) values observed for the two groups.

Compared with trial 1 as well as CON, EXP experienced a diminished IL-6 response both at 0 and 60 min post-test at trial 2. The magnitude of the difference between EXP and CON at these time points was very large, as indicated by the ES of 1.3. The hastened reduction in IL-6 following testing would suggest that supplementation allowed for a faster recovery from the inflammatory response associated with high-intensity anaerobic exercise. This potentially translates to fewer recovery days needed by the athlete, thus allowing for a greater training stimulus and better performance. It is important to note that the inflammatory response still occurred, as some amount of inflammation may be necessary for the physiological adaptations to exercise to transpire^{5,26}. The inflammation was merely dissipated by the body at an accelerated rate for EXP following the supplementation period. There was also remarkable coherence between the pattern of results for IL-6, 8-iso and CORT. This illustrates the important physiological overlap of the inflammatory, oxidative stress and HPA axis responses.

Previous findings for Glisodin supplementation^{15,16} suggest that the hormonal environment may be further enhanced by reductions in oxidative stress response. Throughout the course of an intense pre-season training regimen, this combined effect may improve recovery. The results from this study clearly indicate that reducing the oxidative stress and inflammatory responses to high-intensity anaerobic training improves recovery and permits more frequent training at a productive intensity to enable performance gains.

The encouraging findings with regard to the use of Resurgex Fusion[®] for improving performance, recovery, body composition and biochemical status of the anaerobic athlete warrant further investigation into the use of this product with other power athletes of this calibre and higher levels over longer periods of supplementation. With enhanced recovery following rigorous workout sessions, an overall greater workload in terms of volume and/or intensity may potentially be applied. With decreased damage to the muscle fibres themselves, overtraining and overuse injuries are also not as likely to occur, thus resulting in more consistent training over time and improved performance. Resurgex Fusion[®] supplementation provided improvement in acute recovery after high-intensity anaerobic testing, which translated into long-term benefits of improved body composition, strength and performance.

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