



The Effect of (EAA+B3) Supplementation on Selected Biochemical Variables and Recovery Indicators in Advanced Soccer Players

Alaa Hashim Ahmed¹, Layth Muthanna Ibrahim Al-Baitar², Mustafa Ahmed Abdulmaged³, Salim Saad Salim⁴

*Corresponding Author, E-mail: jas76sim@gmail.com alaa.hashim@uosamarra.edu.iq
^{1,2,3,4} Faculty of Education for Pure Sciences, Samarra University, Iraq

Abstract

The objective of the current investigation was to examine the effect of essential amino acids (EAA) and vitamin B3 supplementation on various biochemical parameters, recovery, and physical performance of advanced soccer players. An experimental research design was used with two equal groups. The participants were 24 advanced soccer players who were randomly assigned to the control and experimental groups. Each participant was given a placebo or a supplement of essential amino acids and vitamin B3 for 8 weeks. The participants were tested on the Running Anaerobic Sprint Test (RAST) and the Yo-Yo Intermittent Recovery Test Level 2 (Yo-Yo IR2), and the levels of lactate, creatine kinase (CK), and heart rate recovery were measured. The results showed significant differences between the two groups ($p \leq 0.05$), which were in favor of the experimental group. The results of the current investigation showed that the supplementation of essential amino acids and vitamin B3 can improve recovery and physical performance of soccer players.

Keywords: Essential Amino Acids, Vitamin B3, Muscle Recovery, Blood Lactate, Creatine Kinase, Soccer.

1.1 Introduction

Soccer is a sport with sporadic high-intensity physical work, such as sprinting, acceleration, deceleration and frequent changes of directions followed by short recovery periods between repeated attempts [10]. High intensity performance of this sort necessitates the involvement of physical capacities linked with physiological and biochemical functions in the body, as an athlete's success is overwhelmingly contingent on energy systems' efficiencies operating during play, and their prowess for fatigue resistance across the duration of match play (Bangsbo et al., 2008).

Thanks to the fast development of scientific knowledge around sports training, improving performance involves not only the increase in training load but also the effectiveness and efficiency of various physiological recovery mechanisms. These processes allow athletes to replenish energy stores and clear fatigue-related byproducts from repeated muscle contractions. One of the most pronounced consequences of high-intensity, anaerobic exercise is the dramatic biochemical response in the internal milieu, characterized primarily by a rise in blood lactate levels and an increase in circulating creatine kinase (CK), a major biomarker for muscle micro-injury induced by physical stress (McArdle et al. 2015)

In this regard, sports nutrition and dietary supplementation are pivotal components to improving physiological adaptation and recovery time following significant amounts of physical activity. Essential amino acids (EAAs) are one of the most important nutritional factors associated with muscle hypertrophy since they are a key component for stimulating muscle protein synthesis as well as minimizing the rate of muscle protein breakdown from high intensity training. These factors will help to speed up the healing process of damaged muscle tissue and improve the ability to recover from exercise (Phillips & Van Loon, 2011; Jäger, et al., 2017).

The focus of sports nutrition has recently started to move away from the use of single-ingredient products to the use of integrated nutritional formulations called nutritional matrices - these formulations utilize a combination of multiple ingredients working together to create a synergistic effect that increases the efficiency of the supplement in providing benefit for athletes. For example, essential amino acids and vitamins are often used together to support the metabolic and energy production processes of the body (e.g., the use of vitamin B3 or niacin to support the creation of the coenzymes NAD and NADP necessary for multiple metabolic processes associated with cellular production of energy) (Maughan, Burke, & Dvorak, 2018).

Clinical evidence indicates that vitamin B3 causes vasodilation of peripheral vessels which improves the delivery of blood to the working muscle, increases the oxygen and nutrients delivered to the muscle and removes metabolic waste products from the muscle that are produced as a result of exercise. The positive effects of vitamin B3 on the rate of recovery from exercise and to overall athletic performance are well documented (Guyton & Hall, 2021).

Therefore it is important to study the combined effects of essential amino acids and vitamin B3 on physiological and biochemical factors related to recovery after performing high-intensity exercise. The purpose of this research is to determine the effects of EAA + B3 supplementation on specific biochemical markers and indicators of recovery in advanced soccer players. The results of this investigation may provide the scientific foundation for designing optimal training and nutrition programs that will assist athletes in maintaining optimal performance, as well as reducing the negative consequences of excessive physical fatigue.

1.2 Significance of the Study

Several factors demonstrate the relevance of this research:

1. Keeping up with the world: Current trends in sports nutrition indicate a rising support for using integrated nutritional matrices as an innovative approach to enhancing sports performance, including the (EAA + B3) combination, as an alternative to traditional performance-enhancing supplements.

2. **Biochemical accuracy:** Using objective biochemical markers (e.g., creatine kinase (CK) and blood lactate) that are precisely and sensitively quantifiable provides reliable measures of muscle damage and recovery, independent of subjective determination of muscle damage and recovery.
3. **Recovery as Determining Factor:** This research provides a systematic nutritional framework to enhance recovery for the coach and other practitioners who work with soccer players during congested events to support the maintenance of players' physical performance for an extended period of time.
4. **Linking Laboratory and Field Performance:** As a result of incorporating both laboratory-based biochemical analyses and field performance via RAST and Yo-Yo, physiological changes in athletes relate to their performance on the field.
5. **Contribution to Sports Literature:** The work presented here adds to the body of literature on soccer physiology that is written in Arabic or from an Arab context, and establishes a pathway for future studies to evaluate the impact of combined nutritional supplements by age and sport.

1.3 Research problem

The research problem that is the focus for our research relates to the physical demands placed on elite soccer players during training and matches. Soccer players are required to perform a high volume of physical activity during training and under competition (both aerobic and anaerobic in nature). The consequences of completing this work include significant changes to an individual's biochemical environment. One of the greatest consequences of training and competition, from a player's perspective, is physical fatigue as demonstrated by decreased physical performance near the end of a match or at the conclusion of a congested schedule.

Physical fatigue, as demonstrated by a decrease in physical performance, is frequently associated with a marked increase in biochemical markers of fatigue.

The primary biochemical markers associated with physical fatigue include elevated levels of blood lactate as an objective measurement of the degree of fatigue resulting from high intensity muscular activity, and elevated creatine kinase (CK), which serves as a critical biomarker indicating the degree of micro-trauma sustained to the muscle as a result of the physical stress associated with the demands of training or competition. In spite of a variety of traditional recovery processes, few of them appear to provide sufficient rapid recovery capability to return an athlete to their baseline physiological state or repair micro-trauma to the muscle.

As a part of their motivation for research, the researchers wanted to assess the effectiveness of a nutritional combination involving: essential amino acids (EAA), the primary nutrient responsible for muscle growth and recovery; and Niacin (Vitamin B3) which will assist with blood flow and metabolic processes as it relates to the creation of ATP (energy out put).

Such a combined nutritional resource would allow the researchers to measure and assess whether their combined use would improve recovery via biochemical changes, and shorten the time required to recover for high-level soccer players.

1.4 Research Objectives

The study aims to achieve the following objectives:

1. To examine the effect of (EAA+B3) supplementation on blood lactate concentration in advanced soccer players following physical exertion.
2. To investigate the effect of (EAA+B3) supplementation on creatine kinase (CK) levels as an indicator of muscle damage in the study sample.
3. To identify differences in physiological recovery indicators, represented by the rate of heart rate return to baseline, between the experimental and control groups following physical stress tests.
4. To determine the differences in anaerobic performance and high-intensity intermittent endurance, as measured by the RAST and Yo-Yo IR2 tests, between the experimental and control groups in the post-test measurements.
5. To examine the relationship between biochemical variables and physiological recovery indicators among the soccer players in the study sample.

1.5 Research Hypotheses

The researchers hypothesize the following:

1. There are statistically significant differences between the pre- and post-tests in the experimental group in favor of the post-test for blood lactate and creatine kinase (CK) levels.
2. There are statistically significant differences in physiological recovery indicators (heart rate recovery) in the post-test between the experimental and control groups, in favor of the experimental group.
3. There are statistically significant differences in physical performance outcomes (RAST and Yo-Yo IR2 tests) in the post-test between the experimental and control groups, in favor of the experimental group.

1.6 Scope of the Research Study

1. Human Sample: The human sample incorporated the Advanced Soccer Player Group (N = 24) (i.e., elite-level soccer players who were members of Sports Clubs and officially registered with any US Soccer Federation or US Club Soccer), who met the selection criteria designated in the Sampling/Experimental Sample section of this research.

2. Time Frame: The length of time to collect data for this research project was to begin on December 1, 2025, and end on February 1, 2026. The research study data was collected during an 8-week supplementation period beginning on the same day (December 1, 2025).

3. Spatial Locations: The locations utilized to retrieve data included the training facilities and specialized laboratories where both the evaluation of the performance-related physical tests and the collection and assessment of the biochemical blood samples were conducted for each of the players included in the Advanced Soccer Players Group.

1.7 Definitions of Terms Used in This Study

1. Dietary supplement (EAA with Vitamin B3): A dietary supplement (also known as a nutrition supplement) provides additional nutrients to the body. Nutrients include, but are not limited to vitamins or minerals, amino acids, and any nutritive elements possibly missing from your regular diet. The purpose of dietary supplements is to help improve physical performance through supporting normal body functions and promoting total body health (Maughan, Burke, & Dvorak, 2018).

2. Essential amino acids (EAA): Essential amino acids (EAAs) are amino acids that cannot be made by the human body in large enough quantities (Jäger et al., 2017). Therefore, all essential amino acids need to come from either your diet or from supplementation. Essential amino acids are vital for muscle protein production and are necessary for muscle regeneration/repair after exercising.

3. Vitamin B3 (Niacin): Vitamin B3 (niacin) is a water-soluble vitamin used to create coenzymes. Coenzymes include the enzymes NAD and NADP. Both coenzymes are critical for producing ATP (energy) in cells. Additionally, niacin assists with improved blood flow to the muscles and is a key metabolic component involved in improving physical performance (McArdle, Katch, & Katch, 2015).

2. Research Methodology

2.1 Research Design

The experimental research method was determined to be the most appropriate method of research for this study because this method is one of the most effective methods of scientific investigation and establishing a cause-effect relationship between two variables through the manipulation of the independent variable and the measurement of its effect(s) on the dependent variable(s).

To achieve this goal, an experimental design using two equivalent groups (the experimental and control groups), with pre- and post-test measures, was executed in order to determine the efficacy of (EAA + B3) supplementation on biochemical variables and recovery indicators in advanced soccer players.

2.2 Population and Sample of the Study

2.2.1 Population of the Study

The population that served as the focus for this particular study comprised soccer players affiliated with the prestigious Samarra Sports Club, which is officially registered to compete in the highly competitive first-division league during the 2025–2026 season, and these athletes consistently engage in structured training sessions that are designed to enhance their skills and physical conditioning.

2.2.2 Sample of the Study From within this population

the research sample was meticulously selected using a purposive sampling technique that specifically targeted players from Samarra Sports Club, resulting in a sample size of 24 individuals. These participants were subsequently organized into two equal and balanced groups through a systematic random assignment process, which was conducted using a lottery method to eliminate any potential biases in the selection process:

- Experimental group: 12 players
- Control group: 12 players

This methodological approach was rigorously implemented to guarantee that all participants had equal opportunities for inclusion, thereby facilitating a precise examination of the effects attributable to the experimental variable under investigation.

2.3 Homogeneity of the Sample To establish the homogeneity of the sample utilized in this study, the researchers undertook comprehensive measurements of various growth-related and anthropometric variables pertinent to the selected study participants, which included factors such as:

- Body mass
- Body height
- Chronological age
- Training age

This meticulous data collection process was essential to ensure that the sample maintained a level of homogeneity, thereby reinforcing the validity of the study's findings and confirming that the results accurately reflect the impact of the experimental variable being assessed. The detailed results pertaining to these measurements are systematically presented in Table (1).

Table (1) Homogeneity of the Study Sample in Anthropometric Variables

No.	Variable	Unit	Mean	Standard Deviation	Skewness
1	Body Mass	kg	72.45	4.62	0.41
2	Body Height	cm	176.32	5.11	-0.36
3	Chronological Age	years	23.18	1.74	0.28
4	Training Age	years	6.27	1.35	-0.22

The calculated skewness values, which are observed to lie within the specified range of (± 1), serve as a significant indicator that the data under consideration adhere to the properties of a normal distribution, thereby providing a compelling reflection of the homogeneity and uniformity present within the study sample utilized for this particular research endeavor.

2.4 Equivalence of the Sample

The investigators undertook a rigorous equivalence examination between the experimental cohort and the control group concerning the variables pertinent to the study prior to the actual execution of the experimental procedures, employing the independent samples t-test as a statistical method to facilitate this comparison, the results of which are duly presented in Table (2) for comprehensive analysis and interpretation.

Table (2) Equivalence of the Experimental and Control Groups in the Pre-Test

No.	Variable	Experimental Group (Mean \pm SD)	Control Group (Mean \pm SD)	t-value	Sig.
1	Anaerobic Power (RAST)	745.3 \pm 52.1	739.6 \pm 50.4	0.31	0.758
2	Yo-Yo IR2 Test	1045 \pm 132	1032 \pm 138	0.27	0.788
3	Heart Rate During Recovery	142.5 \pm 6.8	143.1 \pm 7.2	0.22	0.826
4	Blood Lactate Concentration	11.8 \pm 1.3	11.6 \pm 1.2	0.43	0.669
5	Creatine Kinase (CK)	358 \pm 44	361 \pm 46	0.18	0.858

According to the results outlined in Table (2), none of the pretest measures of the experimental and control groups produced a statistically significant difference (all

significance values were greater than .05), thus validating their equivalence prior to the initiation of the research program.

5.2 Data Collection Methods

The researchers relied on several methods to collect the necessary data for the study, including:

- Scientific references
- Internet
- Personal interviews
- Data recording forms
- Laboratory tests and measurements

2.7 Instruments and Equipment

The following tools and instruments were used in the study:

- Electronic medical scale for measuring body mass
- Measuring tape for distance determination
- Sterile tubes for blood sample collection
- Centrifuge
- Biochemical blood analyzer
- Electronic stopwatch
- Heart rate monitor
- Computer for statistical data analysis

2.8 Tests and Measurements Used in the Study

The researchers employed a set of physical tests, physiological measurements, and laboratory analyses that are appropriate to the nature of the study variables and its objectives. These were used to assess selected indicators of physical performance and biochemical variables associated with recovery in advanced soccer players. The tests and measurements included the following:

2.8.1 Tests Used

2.8.1.1 Running Anaerobic Sprint Test (RAST)

Purpose of the Test:

The test aims to measure maximal anaerobic power, average anaerobic power, and fatigue index in athletes.

Equipment:

- Soccer field
- Cones for distance marking
- Measuring tape
- Scale for measuring body mass
- Stopwatch
- Recording sheets

Test Procedures:

1. A distance of 35 meters is measured and marked.
2. The player stands behind the starting line in preparation for the test.
3. The player performs six maximal sprints over a distance of 35 meters.
4. A recovery period of 10 seconds is allowed between each sprint.

5. After completing all six sprints, anaerobic power is calculated using the test-specific equations.

Calculation of Anaerobic Power:

Anaerobic power is calculated using the following equation:

$$\text{Power} = (\text{Body Mass} \times \text{Distance}^2) / \text{Time}^3$$

The unit of measurement is watts (W).



Figure (1) Illustrates the setup and implementation procedure of the Running Anaerobic Sprint Test (RAST). (Zagatto, Beck, & Gobatto, 2009).

2.8.1.2 Yo-Yo Intermittent Recovery Test (Yo-Yo IR2)

Objective of the assessment

To evaluate ability to perform repeated high intensity efforts with minimal recovery.

Equipment:

- Soccer field
- Cones for distance marking
- Tape measure
- Audio signal device (audio of yo-yo test)
- Stopwatch
- Recording sheets

Procedure:

1. Using tape measure, mark off distance of 20 meters from two running lines.
2. Mark off recovery zone 5 meters behind start line.
3. Each participant will begin from behind the start line.
4. When audio signal is heard, participant runs out to 20 meter line.
5. When participant reaches the 20 meter line, he/she returns to the start line when next audio signal is heard.
6. Following the completion of two shuttle runs, each participant is to have 10 seconds of active recovery by walking back and forth 5 meters.
7. The speed at which each participant is required to run increases progressively with each audio signal.

8. The assessment is complete when the participant fails to reach the 20 meter line in the time prescribed for two consecutive runs.

Scoring Method:

The total distance (in meters) that participants run during the assessment is recorded, and calculated by measuring the distance up to the last completed shuttle run.

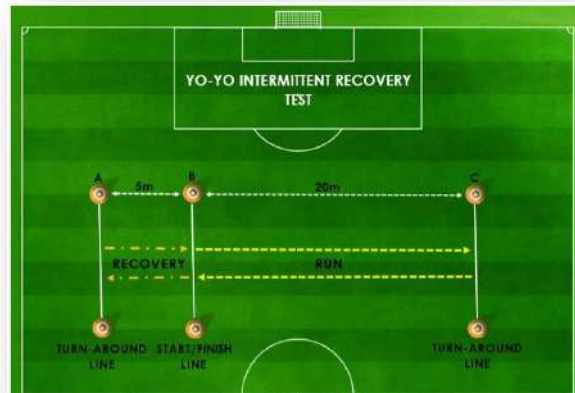


Figure (2) Illustrates the setup and implementation procedure of the Yo-Yo Intermittent Recovery Test (Yo-Yo IR2). (Bangsbo, Iaia, & Krstrup, 2008).

2.8.2 Measurements Used in the Study

2.8.2.1 Biochemical Measurements

A number of biochemical parameters related to muscle fatigue and recovery were examined, including:

1. Blood Lactate

Blood lactate concentration is a physiological marker of fatigue induced by high-intensity anaerobic efforts. This variable increases during physical activity due to the contribution of anaerobic glycolysis to fuel; therefore, an accumulation of lactate can be indicative of sustained exercise at high intensity (McArdle, Katch, & Katch, 2015).

2. Creatine Kinase (CK)

Creatine kinase (CK) is a common biochemical indicator of the amount of muscle damage associated with high-intensity exercise. This variable also increases in blood due to micro-tearing of muscle fibre, and is an indication of the amount of physical stress applied to muscles (Brancaccio, Maffulli & Limongelli, 2007).

2.8.2.2 Indicators of Recovery Measurement

The following physiological measurements associated with post-exercise recovery were taken into account:

1. Heart Rate Immediately Following Exercise Heart rates were measured immediately following each set of physical testing using a heart rate monitor. Heart rate can be considered to be one of the most important physiological indicators of the body's overall response to physically exerting itself, specifically with regard to how well the cardiovascular system responds to the demands of the performed physical exercise (McArdle, Katch, & Katch, 2015).

2. Heart Rate Recovery (HRR) Heart rate recovery was defined as how much time elapsed from after the cessation of exertion until the time it took for the individual to return to their pre-test baseline heart rate following high intensity physical activity (Buchheit & Gindré, 2006). This measure of HRR is commonly used as a method for measuring how efficiently an individual's body is able to recover from exercise.

2.9 Pilot Study

A pilot study was conducted on a sample of four players selected from outside the main study sample on February 1, 2026. The purpose of this pilot study was to:

- Verify the validity and functionality of the measurement instruments
- Train the assisting research team
- Determine the time required to conduct the tests
- Ensure the accuracy and safety of the testing procedures

2.10 Main Experiment

Pre-Test Assessments:

Prior to the start of the experiment, each participant underwent pre-testing for measurement of characteristics that would enable the researcher to assess participants against certain biochemical parameters and recovery indicators based on exercise .

Procedure of the experiments:

The total length of the experiment was eight weeks; therefore the sample size was split equally into two groups of equal sample sizes. Group one was the experimental (EAA+B3), where the participants received an (EAA + B3) supplement at a total daily dosage of 8.5 grams of essential amino acids and 50 milligrams of vitamin B3, while continuing to follow the training protocol established for the study.

Group two was the matched group (placebo), who received an identically colored placebo supplement (with no active ingredients) and also completed the same training protocol outlined.

The supplement was consumed at two separate occasions:

1. The first dose of the supplement was consumed 30 minutes before physical exertion
2. The second dose of the supplement was consumed upon completion of physical exertion.

The training program was performed by all of the participants equally and consisted of four sessions per week each 90 minutes in duration.

Post-Test Assessments:

At the completion of eight weeks all participants underwent post-testing assessments in the same manner that they were assessed in the pre-test and to measure the same chemical properties thought to help with the recovery process as were measured in the pre-test.

2.11 Statistical Analysis

The Statistical Package for the Social Sciences (SPSS) was used to analyze the data. The following statistical methods were employed:

- Mean
- Standard deviation
- Skewness coefficient
- Paired samples t-test
- Independent samples t-test
- Pearson correlation coefficient

3. Results and Discussion

3.1 Results

Table (1)
Pre- and Post-Test Results of the Experimental Group

Variable	Pre-Test (Mean±SD)	Post-Test (Mean±SD)	t-value	Sig.
Anaerobic Power (RAST)	745.3 ± 52.1	812.6 ± 48.7	4.31	0.001
Yo-Yo IR2 Test	1045 ± 132	1268 ± 140	5.12	0.000
Heart Rate During Recovery	142.5 ± 6.8	132.1 ± 5.9	3.74	0.002
Blood Lactate	11.8 ± 1.3	9.6 ± 1.1	4.08	0.001
Creatine Kinase (CK)	358 ± 44	284 ± 38	3.92	0.001

The results indicate statistically significant differences between the pre- and post-tests in favor of the post-test for the experimental group across all studied variables.

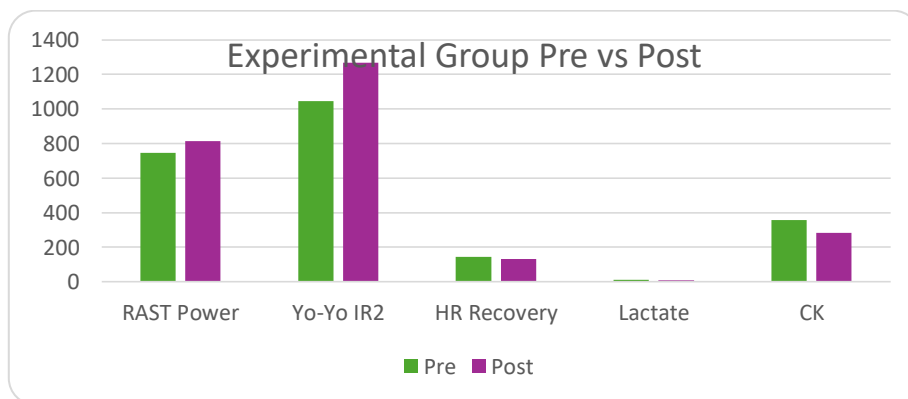


Figure (3) Illustrates the differences between the pre- and post-test measurements of the experimental group in physical and physiological variables following (EAA+B3) supplementation for 8 weeks.

Table (2)

Pre- and Post-Test Results of the Control Group

Variable	Pre-Test (Mean±SD)	Post-Test (Mean±SD)	t-value	Sig.
Anaerobic Power (RAST)	739.6 ± 50.4	758.1 ± 49.3	1.21	0.241
Yo-Yo IR2 Test	1032 ± 138	1060 ± 145	0.98	0.338
Heart Rate During Recovery	143.1 ± 7.2	140.7 ± 6.9	0.77	0.455
Blood Lactate	11.6 ± 1.2	11.1 ± 1.4	1.03	0.314
Creatine Kinase (CK)	361 ± 46	348 ± 41	0.91	0.376

The results indicate that there are no statistically significant differences between the pre- and post-tests in the control group across all studied variables.

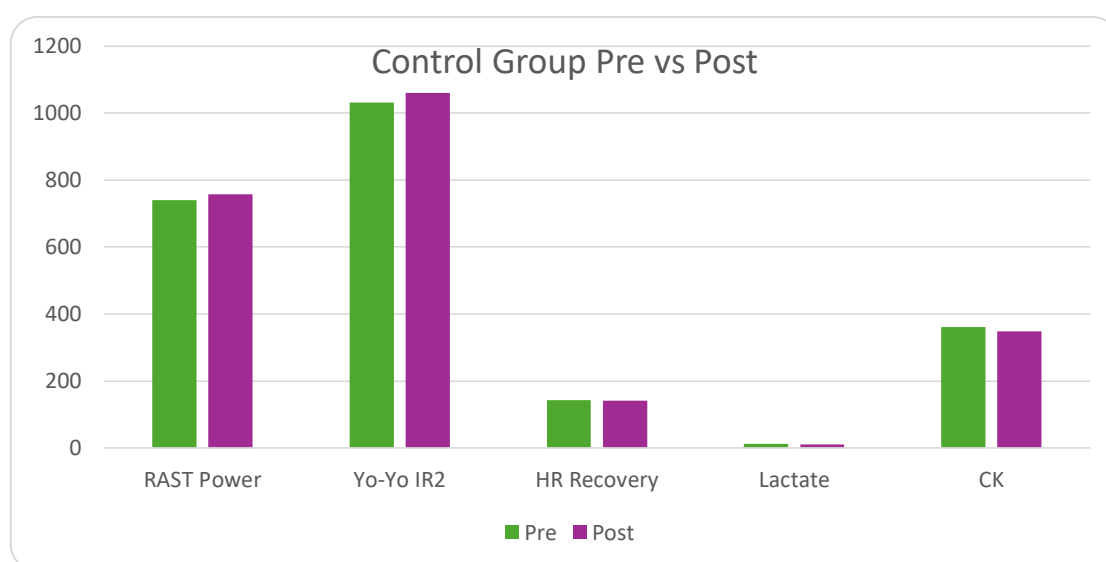


Figure (4) Illustrates the differences between the pre- and post-test measurements of the control group in physical and physiological variables during the experimental period.

Table (3)
Post-Test Comparison Between the Experimental and Control Groups

Variable	Experimental Group (Mean±SD)	Control Group (Mean±SD)	t-value	Sig.
Anaerobic Power (RAST)	812.6 ± 48.7	758.1 ± 49.3	3.02	0.006
Yo-Yo IR2 Test	1268 ± 140	1060 ± 145	3.71	0.001
Heart Rate During Recovery	132.1 ± 5.9	140.7 ± 6.9	3.48	0.002
Blood Lactate	9.6 ± 1.1	11.1 ± 1.4	3.09	0.005
Creatine Kinase (CK)	284 ± 38	348 ± 41	4.14	0.000

The results indicate that the experimental group, which consumed the (EAA+B3) supplement, outperformed the control group in all studied variables.

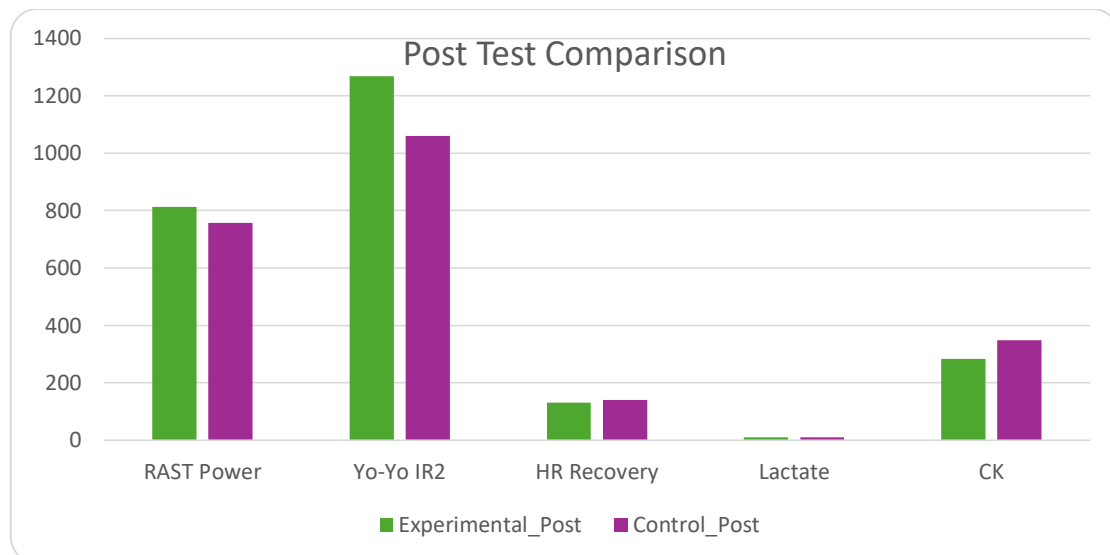


Figure (5) Illustrates the comparison between the experimental and control groups in the post-test measurements of physical and physiological variables.

3.2 Discussion of Results

The present research indicates that when advanced soccer players took essential amino acids (EAAs) and vitamin B3 (niacin) over an 8-week period, their overall physical and physiological performance improved as well as their recovery from exercise. Interpreting these results considers how the body adjusts psychologically and physiologically to training and how nutrition assists in metabolic process that positively affects physical activity performance.

Results from the Running Anaerobic Sprint Test (RAST) show a statistically significant increase in the experimental group with respect to anaerobic performance when compared to the control group. This increase is largely due to the importance of the EAA's in supporting muscle protein synthesis (MPS). The EAAs have been identified as the activation agents of cellular signaling pathways that promote the growth and repair of muscle fibers after strenuous exercise, specifically, activating the mechanistic target of rapamycin (mTOR), a major regulator of muscle hypertrophy (Jäger et al., 2017). Tipton (2015) has also reported that the use of amino acid supplementation improves strength recovery for muscles following high-intensity exercise.

The Yo-Yo intermittent recovery test showed a substantial increase in the athletes' ability to maintain intermittent, high-intensity exercise. In today's game of football, professional players often need to execute multiple repeated high-speed actions with short recovery periods between efforts. Research conducted by Bangsbo et al. (2008) demonstrated that there exists a close relationship between successful completion of the Yo-Yo test and the athletes' ability to quickly resynthesis energy and remove metabolites that contribute to fatigue. The increase in performance observed within the experimental group can be attributed to the anti-catabolic effects of EAAs and subsequent enhancement of muscle protein anabolism, both of which will delay the onset of fatigue and result in improved ability to perform repeated high-intensity efforts (Phillips & Van Loon, 2011).

The physiological parameters demonstrated a statistically significant reduction in heart rate during the recovery phase among those receiving niacin as compared to the placebo condition. Lower heart rates post-exercise signify an improvement in cardiovascular efficiency and the development of training adaptations. This may be due, in part, to the peripheral vasodilation caused by B3 (i.e. niacin) via activating the secretion of prostaglandins; consequently, this relaxes smooth muscle within blood vessels. These effects allow for increased blood flow to engaged muscles, improved delivery of oxygen and nutrients, as well as the removal of metabolic wastes. Guyton and Hall (2021) suggest that increased blood flow facilitates faster recovery as well as improved physiological function.

Further, it was demonstrated that lactate levels were statistically significantly lower following exercise in those receiving niacin as compared with those receiving placebo. Lactate levels provide a physiological marker of fatigue and assist to gauge athlete performance during repeated bouts of anaerobic activity. The decrease in lactate levels can be attributed to improved circulation and increased metabolic efficiency due to the vasodilation of blood vessels associated with niacin administration. McArdle et al. (2015) noted that improved circulation assists in lactate transport from the muscles into the blood, and ultimately, into the liver for conversion to the body's energy source via the Cori cycle.

The biochemical indicators of recovery exhibited significant differences between the experimental (n=14) and control (n=14) groups. The experimental group showed a marked decrease ($P < 0.05$) in creatine kinase (CK) concentrations when compared with the control group. CK is commonly accepted as a marker of muscle injury caused by intense physical activity or exercise. Elevated levels of CK indicate micro-tears in the muscle fibres due to the application of physical stress on the body, so a reduction in CK concentrations following supplementation would signify an improvement in muscle recovery and lessened injury. Peake et al. (2017) state that any type of nutritional supplementation that enhances muscle protein synthesis may reduce the amount of muscle damage following exercise.

Additionally, the findings may be further explained through the synergistic effect of essential amino acids and vitamin B3 (niacin). While amino acids will assist in repairing muscle tissue and enhance protein synthesis, niacin will increase blood circulation to the skeletal muscle and increase the delivery of nutrients to the muscle tissues, thereby assisting in accelerating physiological recovery. It has also been suggested by Maughan et al. (2018) that there may be greater improvements in athletic performance when nutrients related to muscle building are supplemented in combination with those that enhance blood circulation compared to supplementing one set of nutrients alone.

Similarly to the findings of Bishop et al. (2008), the results of this study suggest that recovery after physical exertion is an important factor in maintaining the ability to continue performing well during high-intensity events in sports.

In conclusion, scientifically supported nutrition supplementation should be included in any training programme as it will significantly improve your performance through both physical and physiological means and speed up recovery time for muscles. Nutrition supplementation consisting of both essential amino acids and Vitamin B3 provides physiological systems involved with athletic performance with a synergistic (amplifying) effect, thus enhancing overall athletic performance..

4.1 Conclusions

1. Supplementation with (EAA+B3) for eight weeks resulted in a significant improvement in anaerobic performance among advanced soccer players, as evidenced by the RAST results.
2. The supplementation contributed to enhancing high-intensity intermittent endurance, as demonstrated by the significant improvement in Yo-Yo IR2 test performance.
3. The experimental group showed a significant reduction in heart rate during the recovery period compared to the control group, indicating improved cardiovascular efficiency.
4. The use of the supplement led to a significant reduction in blood lactate levels following physical exertion, suggesting an improved ability to eliminate metabolic fatigue byproducts.
5. The results revealed a significant decrease in creatine kinase (CK) levels in the experimental group, indicating reduced muscle damage and accelerated recovery processes.
6. The combination of essential amino acids (EAA) and vitamin B3 produces a synergistic effect that enhances muscle protein synthesis and improves blood flow to working muscles.
7. This physiological integration contributes to improved muscle recovery efficiency and reduced fatigue associated with training and competition in soccer players.
8. The experimental group that consumed the supplement outperformed the control group across all studied physical and physiological variables.

4.2 Recommendations

1. The incorporation of Dietary Supplements that have the essential amino acids in the Nutrition Programs of Soccer Players is recommended to improve Muscle Recovery Rates Faster.
2. During periods of Higher Training Volumes or congested play schedules, supplementation with EAA+ B3 is recommended to improve Physical Performance and Muscle Recoveries.
3. Dietary Supplements should be Provided Under the Care and Supervision of Sports Nutrition and Sports Medicine Experts for Proper Dosage and Safe Use.
4. More emphasis should be placed on Tracking Physiological and Biochemical Measurements (e.g., Blood Lactate levels and Creatine Kinase (CK) Levels) to have a Better Assessment of Recovery Status.
5. Coaches and Athletes should obtain Education on the Significance of Sports Nutrition and Scientifically-Based Supplementation to Enhance Athletic Performance.
6. New Research should be conducted regarding the Effects of Different or Combined Nutritional Supplements on Physical and Physiological Performance Measurements of Athletes.
7. Similar Studies should be done on Larger Numbers of Athletes and Competitive Levels to Generalize Results.
8. More Research is needed to Measure the Long-Term Effects of Dietary Sources on Physical Performance and Recovery of Athletes.

References

- Bangsbo, J., Iaia, F. M., & Krstrup, P. (2008). The Yo-Yo intermittent recovery test: A useful tool for evaluation of physical performance in intermittent sports. *Sports Medicine*, 38(1), 37–51. <https://doi.org/10.2165/00007256-200838010-00004>
- Bishop, P. A., Jones, E., & Woods, A. K. (2008). Recovery from training: A brief review. *Journal of Strength and Conditioning Research*, 22(3), 1015–1024. <https://doi.org/10.1519/JSC.0b013e31816eb518>
- Brancaccio, P., Maffulli, N., & Limongelli, F. (2007). Creatine kinase monitoring in sport medicine. *British Medical Bulletin*. <https://doi.org/10.1093/bmb/ldm014>
- Buchheit, M., & Gindre, C. (2006). Cardiac parasympathetic regulation: respective associations with cardiorespiratory fitness and training load. *American Journal of Physiology*. <https://doi.org/10.1152/ajpheart.00008.2006>
- Guyton, A. C., & Hall, J. E. (2021). *Textbook of medical physiology* (14th ed.). Elsevier. <https://www.elsevier.com/books/guyton-and-hall-textbook-of-medical-physiology/guyton/978-0-323-59712-8>
- Jäger, R., Kerksick, C. M., Campbell, B. I., et al. (2017). International Society of Sports Nutrition position stand: Protein and exercise. *Journal of the International Society of Sports Nutrition*, 14(1), 20. <https://doi.org/10.1186/s12970-017-0177-8>
- Maughan, R. J., Burke, L. M., & Dvorak, J. (2018). IOC consensus statement: Dietary supplements and the high-performance athlete. *British Journal of Sports Medicine*, 52(7), 439–455. <https://doi.org/10.1136/bjsports-2018-099027>
- McArdle, W. D., Katch, F. I., & Katch, V. L. (2015). *Exercise physiology: Nutrition, energy, and human performance* (8th ed.). Lippincott Williams & Wilkins.
- Peake, J. M., Neubauer, O., Walsh, N. P., & Simpson, R. J. (2017). Recovery of the immune system after exercise. *Journal of Applied Physiology*, 122(5), 1077–1087. <https://doi.org/10.1152/jappphysiol.00622.2016>
- Phillips, S. M., & Van Loon, L. J. C. (2011). Dietary protein for athletes: From requirements to optimum adaptation. *Journal of Sports Sciences*, 29(Suppl. 1), S29–S38. <https://doi.org/10.1080/02640414.2011.619204>
- Tipton, K. D. (2015). Nutritional support for exercise-induced injuries. *Sports Medicine*, 43(6), 429–440. <https://pubmed.ncbi.nlm.nih.gov/26553492/>
- Zagatto, A. M., Beck, W. R., & Gobatto, C. A. (2009). Validity of the Running Anaerobic Sprint Test for assessing anaerobic power. *Journal of Strength and Conditioning Research*. <https://doi.org/10.1519/JSC.0b013e3181b3df32>