The Effect of Dietary Supplements on Some Biochemical Variables in Female Track and Field Athletes

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Abstract

The present study aimed to investigate the impact of dietary supplements on some biochemical variables (lactate, creatine kinase CK, lactate dehydrogenase LDH, and ammonia) in heptathlon athletes in relation to their athletic performance. The sample consisted of 5 athletes who had been selected to participate in the study. An experimental approach was used through a pre-post comparison of an experimental group that received dietary supplements. Significant improvements in some of these biochemical variables were observed in the study sample, indicating the role of supplements in enhancing athletic performance and accelerating muscle recovery. In this regard, the study recommended the addition of dietary supplements to the nutritional regimen of heptathlon athletes, although determining the appropriate dosage for each individual athlete is necessary. Further studies are also needed to determine the physiological mechanisms by which dietary supplements affect these biochemical variables and overall athletic performance.

Key words: dietary supplements, biochemical variables, athletic performance, creatine kinase.

Introduction

The astonishing success in terms of athletic achievement and the breaking of new records at world championships all over the world are related to scientific innovations that have now become a signature of world sports. Sports physiology evolved as the most important form of applied science that has succeeded in facilitating these leaps, as well as in furthering scientific research and findings in both theoretical and applied aspects concerning the improvement of achievement in athletes while maintaining their safety and well-being (3:3).

The decathlon and heptathlon combine the three basic disciplines of track and field: running, jumping, and throwing, requiring a combination of speed, explosive power, and endurance. Competition is mediated through a points system awarded to each competitor for their performance in each event according to the IAAF scoring tables, and the winner is the athlete who completes all events in the competition and accumulates the highest total score. To compete successfully at elite levels, a relatively high and consistent performance across all individual disciplines is required. As such, Olympic decathlon and heptathlon champions are often referred to as "the world's greatest athletes," a reference to the alleged statement made by Swedish King Gustav V to American Jim Thorpe after Thorpe's 1912 Olympic decathlon victory. (19)

Dietary supplementation refers to the provision of the body with essential nutrients aimed at enhancing muscular efficiency using a variety of alternatives available for natural and basic nutrition. In addition, it can maintain the storage of the vitamins, minerals, and other nutrients the body requires during performance. (15:9)

Sport nutrition has turned into a widely investigated field of sport. Depending on the form of athletic performance, it can have a positive influence on the anabolic processes of different body systems, promoting recoveries after hard exercises. Besides, it can fasten the process of recovery and give a possibility to return to training process sooner. Enzymes like CPK participate in the processes of ATP regeneration in muscle cells. Thus, depending on the needs of the athlete, specific supplements-such as creatine, phosphorus, amino acids-will help in ensuring positive recovery and rebuilding processes. Most researchers have identified carbohydrates, amino acids, and creatine as supplements which are quite important for overall athletic performance, especially those sports involving speed. (13:15)

The nature of combined events dictates so many and varied training that the total hours spent in training by a heptathlon athlete surpasses those of many sports, thus setting a great demand to supplement the heptathlon athlete's diet with concentrated nutrients found only in dietary supplements. Secondly, the physiological demands brought about by competition in combined events calls for highly concentrated diets both before, during, and after the intense competition itself. (16:586)

In 2003, Zaidoun Jawad Mohammed Joudi reported the study entitled "The Effect of Different Ratios of Creatine Phosphate Compound on Developing Muscle Strength and Performance in 100-meter Elite Runners" (8). The study aimed to find the concentration of creatine phosphokinase (CPK) enzyme in the blood before and after exertion, as well as other physical indicators and the level of muscle component in 100-meter runners. The method used was experimental, with a sample size of 6 athletes. The most considerable result of this study was derived from the loading principle having a positive effect on raising the body's efficiency to produce ATP. This was reflected in the results of the 7-second running test in the post-tests, and it clearly developed muscle power and working groups, whether relying on the loading principle or the regular dose. The differences were significant between the post-tests and pre-tests for both groups in the standing long jump test.

Akram Hussein Jabr Al-Janabi (2006) presents the study, "The Use of Different Ratios of Creatine Phosphate and Its Effect on Short-Distance Performance (400, 200, 100m)" (5). This research was done in order to determine the level of development in the performance of running in distances of 400, 200 and 100 meters using the two methods: a regular dose method and a fluctuating dose method of creatine phosphate. Material and Methods The work was based on an experimental approach, while the sample included 18 athletes. As for the results, there was a positive influence from the use of creatine phosphate compound in developing the performance in running over distances of 400, 200, and 100m with positive post-tests.

By Sirawan Hamed Rafik in the year 2016, "The Effect of Using Creatine Phosphate Loading on Developing CPK Enzyme and Performance of 200m Runners" 11. This research was conducted to study the influence of the creatine phosphate compound on the development of the creatine phosphokinase enzyme in 200-meter youth runners. This was an experimental method involving a sample size of 10 athletes. The most striking results were that the nutritional program in combination with the prepared training program influenced the development of 200-meter running performance and enhanced the activity level and percentage of the CPK enzyme in the cells of the experimental group. The application of the loading principle for dietary supplements proved to be more effective compared to their administration as a regular dose. The high concentration of the CPK enzyme is a good indicator of muscle work, but when the concentration of this enzyme decreases while continuing to exert the same level of physical effort, this is a good indicator of muscle adaptation and energy economy.

The study might be considering that there is scant information, to the best of the researchers' knowledge, regarding the biochemical variables resulting from different intensity training programs combined with dietary supplements. This might have compelled the researcher to conduct a scientific study aimed at identifying and comparing the biochemical responses of lactate, creatine kinase (CK), lactate dehydrogenase (LDH), and ammonia using specific dietary supplements. The present study was undertaken to ascertain the response of these biochemical variables in heptathlon athletes by controlling the duration of work and rest periods.

Methods

Research Methodology:

The researcher used an experimental research design since it suits the nature of this study.

Sample:

The researcher selected a purposive stratified sample of heptathlon athletes from the 6th of October Club, who ranked from first to eighth in the Republic Championship. The sample size was five athletes.

Sample Description:

Table (1): Sample Description (n = 5)

Variable	Unit	Mean ($\bar{X}$)	Standard Deviation (SD)	skewness
Age	Years	17.40	0.55	0.61
Height	cm	165.00	1.58	0.00
Weight	kg	52.00	2.00	0.94
Training Experience	Years	4.00	0.48	0.59

The table above gives the mean, standard deviation, and skewness for the growth variables for the whole sample. It follows from the results that the distribution of the sample is relatively normal for these variables since the values of skewness are within the range of ±3.

Data Collection Methods

The researcher employed several methods to collect data for this study, including:

1. Literature review of Arabic and international research.
2. Questionnaires.
3. Measurements and tests.

Experiment Phases

Pre-Experiment Phase

Getting consent:

The researcher explained to the players and coaches how important this research is, in order for them to agree with the experiment.

Choosing a laboratory:

The researcher visited a few medical laboratories of analysis and asked doctors with specialization in the type of specific analysis.

Coordination with the laboratory:

The researcher contacted a specialized laboratory (Dr. Emad Fouzy's laboratory at the National Heart Institute) to carry out the medical analyses, to identify a specialist to draw blood samples, and to specify appointment times.

Assigning assistants:

The researcher provided assistants to organize appointments and ensure punctuality.

Equipment and tools:

- Plastic syringes for blood drawing
- Glass tubes for storing blood components and EDTA preservative
- Medical cotton, antiseptic alcohol, and medical tape.
- An ice box containing crushed ice for blood sample tubes during transportation.
- A thermometer with a range of 10 to 100 degrees Celsius.

Experimentation Phase

Sample homogeneity:

The researcher made sure the sample group was homogeneous in terms of age, training experience, and physical fitness level.

The measurements that were taken beforehand were considered the baseline measurements; these were taken on Wednesday, November 2, 2022, at the end of the general preparation period, while the players were completely rested before the warm-up.

Blood sampling:

Blood samples were collected from all participants with the help of a specialized physician from the analysis laboratory 15 minutes before the start of each training session.

Training Session:

The training session was conducted, including a 15-minute warm-up consisting of running and stretching exercises.

Post-training Blood Sampling:

Blood samples were collected immediately after the training session.

Statistical Analysis:

The researcher utilized non-parametric statistics using the Statistical Package for the Social Sciences (SPSS) software due to its suitability for the nature of this study, the measurements used, and the sample size. The following statistical procedures were employed: means, standard deviations, skewness, rates of change, Wilcoxon Signed-Rank Test .

Results

Table (2): Wilcoxon Signed-Rank Test for the Significance of Differences in Pre-Supplementation Biochemical Variables Between Rest and Exercise Conditions in the Studied Athletes

Variable	**Z**	**p**	**Sig.**
Lactate	-24.725	0.000	significant
CK	-5.842	0.004	significant
LDH	-9.492	0.001	significant
Ammonia	-5.788	0.004	significant

Table (2) clearly shows that there are statistically significant differences between the rest and exercise conditions for the studied variables, with the exercise condition showing higher values.

Table (3): Mean, Standard Deviation, and Rate of Change of Biochemical Variables in the Studied Athletes (Rest vs. Exercise) in the First Measurement Before Supplementation (n=5)

Measurements / Variables	**Units**	**Rest**		**Exercise**		**Rate of Change**
		Mean	**SD**	**Mean**	**SD**	**%**
Lactate	umol/l	1.09	0.14	2.97	0.19	172.48
CK	U/L	107.20	16.12	178.40	20.49	66.42
LDH	U/L	294.80	51.16	363.60	66.67	23.34
Ammonia	umol/l	178.60	25.32	207.60	31.20	16.24

Table (3) clearly shows an increase in mean values and rate of change of the studied biochemical variables in the athletes before supplementation.

Table (4): Wilcoxon Signed-Rank Test for the Significance of Differences in Biochemical Variables Between Exercise and Rest Conditions in the Studied Athletes in the Second Measurement Post-Supplementation

Variable	**Z**	**p**	**Sig.**
Lactate	-29.272	0.000	significant
CK	-7.052	0.002	significant
LDH	-7.570	0.002	significant
Ammonia	-1.744	0.156	Non-significant

Table (4) clearly shows that there are statistically significant differences between the rest and exercise conditions for most of the studied variables, with higher values observed during exercise, except for Ammonia

Table (5): Mean, Standard Deviation, and Rate of Change of Biochemical Variables in the Studied Athletes (Rest vs. Exercise) in the Second Measurement Post-Supplementation (n=5)

Measurements / Variables	Units	Rest		Exercise		Rate of Change
		Mean	SD	Mean	SD	%
Lactate	umol/l	1.13	0.14	2.64	0.19	133.63
CK	U/L	99.60	12.54	150.60	7.70	51.20
LDH	U/L	267.20	38.53	340.20	48.93	27.32
Ammonia	umol/l	178.00	26.64	204.40	28.06	14.83

Table (5) clearly shows an increase in mean values and rate of change for the studied biochemical variables in the athletes during the second measurement post-supplementation, with higher values observed during exercise compared to rest.

Table (6): Change in Biochemical Variables from the First Measurement (Pre-Supplementation) to the Second Measurement (Post-Supplementation) in the Study Group (n=5)

Variables	units	rest		Rate of Change%	exercise		Rate of Change%
		Before supp	After supplement		Before supp	After supplement	
Lactate	umol/l	1.09	1.22	11.47%			%-7.20
CK	U/L	107.20	95.50	-10.91%	178.40	148.50	% -16.76
LDH	U/L	294.80	234.00	% -20.62	363.60	296.00	%-18.59
Ammonia	umol/l	178.60	166.50	% -6.77	207.60	214.50	%3.32

Table (6) reveals that most biochemical variables decreased after supplementation during rest, except for lactate. During exercise, most variables decreased except for ammonia.

Discussion

Table (1) presents the mean and standard deviation of the study group's overall scores for the variables of age, height, weight and training age. Table 2: Shows the significant differences in the level of significance between the rest and exercise conditions in the variables studied in the heptathlon group for the benefit of the exercise condition. And The results in Tables (4) and (5) show a significant increase in lactate, CK, LDH, and ammonia levels immediately post-exercise in the supplemented study participants. This was most evident during the second measurement, post-supplementation, where the percentage changes were 133.63%, 51.20%, 27.32%, and 14.83% for lactate, CK, LDH, and ammonia, respectively, under both rest and exercise conditions. The researchers attribute these findings to the biochemical changes related to muscle damage, occurring in several stages. In the early stages of such biochemical changes, the muscle is able to bear the training load, thus stimulating the production of cytokines. Cytokines increase blood flow to the liver to enhance glycogen synthesis and remove metabolic waste products. The above biochemical variable positive responses to training loads before reaching fatigue agree with the studies conducted by Pura et al. (2013), which suggest that skeletal muscles secrete large amounts of interleukin-6 after prolonged exercise-myokines-that may have some functional significance for the development and hypertrophy of muscles. Further, myokines may exert systemic effects on the liver, adipose tissue, immune system, and vasculature, as confirmed by Gibala (2009). On a cell-signaling level, high-intensity, short-duration exercise is associated with pathways that promote muscle growth, such as post-exercise nutrient replenishment, increased mitochondrial biogenesis, and increased capacity for glucose and fatty acid oxidation. If the load of training is excessive or if the athlete is reaching fatigue, inflammation and muscle damage result. This coincides with Abu El-Ela Ahmed Abdel Fattah et al. (2016), Kevin Zwetsloot et al. (2014), Kasmai et al. (2014), and Rodrigo et al. (2012), who mentioned that muscle inflammation is a result of capillary congestion and metabolic waste products due to high-intensity exercise. Tissue innervation is stimulated due to inflammation, which enables the activation of immune as well as biochemical inflammatory markers. Vassillis (2007) highlighted that a series of biochemical markers can precisely determine the training load in an effective manner. Increased CK levels in athletes ensure training at overloading and progressive overload principals, which are crucial in tachet adaptation to exercise. Conversely, excessively high CK levels may signal the need to reduce training load to prevent muscle injury and overtraining. As can be seen from Table 6, the changes in biochemical variables from the first measurement (before the strength training program) to the third measurement (after the strength training program and supplementation) favored the first measurement during rest, except for lactate. During exercise, the first measurement also showed favorable results for most biochemical variables, with the exception of ammonia.

It has been pointed out by a number of researchers, including Cipryan L 2017, Clarkson et al. 2006, Wiewelhove T et al. 2019, Gustavo A. 2017, and Brancaccio P 2007, that these biochemical markers are important objective markers which coaches could utilize to evaluate the effect of different loads in training on athletes. Coaches would then be in a better position to make necessary adjustments before, during, and after training using scientific principles.

Conclusions and Recommendations

Based on the research objectives and the validity of the hypothesis, the following conclusions were reached:

1. The use of training combined with certain supplements led to positive changes in several biochemical variables (Lactate, CK, LDH, Ammonia) in the study sample.
2. A training program combined with certain supplements was more effective than a training program without supplements, which positively affected all study variables.
3. The levels of biochemical variables (Lactate, CK, LDH, Ammonia) increased during exercise.
4. The levels of some biochemical variables decreased during rest as a result of using certain supplements.
5. The levels of some biochemical variables decreased during exercise as a result of using certain supplements.

Based on the findings, the following recommendations are proposed:

1. It is recommended to add supplements to the dietary plans of high-level athletes, especially in strength-based activities.
2. Athletes should consume a variety of protein sources in different forms and avoid relying on a single type of protein.
3. It is not recommended for athletes under the age of 16 to consume supplements, especially protein supplements and their derivatives, due to the lack of need for them and the lower training loads. This is also not recommended by doctors and specialists.
4. The dosages of supplements consumed by athletes should be tailored to the training loads they are exposed to, and specialists and doctors should supervise the regulation of these dosages.
5. It is important to achieve the required balance of nutrients in the dietary plan of high-level athletes and to conduct a thorough analysis of the nutritional requirements of the specialized

sports activity and the need to supplement the diet with nutritional supplements.

6. Further studies are needed to investigate the effects of different protein and carbohydrate intake ratios on other factors and variables.

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