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Original article

Study of biochemical indicators in the urine of juvenile female sabre athletes in training

Estudio de indicadores bioquímicos en la orina de atletas juveniles de sable femenino en entrenamiento

Estudo de indicadores bioquímicos na urina de jovens atletas do sexo feminino sabre em treino

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ABSTRACT

The present study aims to determine the behavior of some biochemical indicators in the urine of female sabre athletes, of juvenile age, after a training session, among which pH (reaction), glucose, albumin and one of the three ketone bodies (acetone) stand out. The sample was represented by seven female sabre athletes, belonging to the provincial fencing academy, youth category, with an average age of 16 years and two years of experience. The statistic used for comparisons was the mean. The determination of pH, quantitatively in urine, was through pH paper. Glucose was determined by the Benedict's reagent method. Albumin was determined in urine, through the sulfosalicylic acid method. In addition, acetone was determined by Imbert's method. The motivation for the research is due to the incorporation of the female sabre in contemporary fencing, which studies the characteristics and performance of the female sex in the sabre, a very fast and strong weapon. The results show how the load applied during a training session of a selected microcycle of the special preparation caused variations in most of the indicators, demonstrating the appearance of a state of acidosis in the urine, as a consequence of the work performed. The usefulness of the determination of albumin to characterize the intensity of the physical load was also confirmed.

Keywords: Biochemical Indicators; pH; Glucose; Albumin; Acetone; Acetone.

RESUMEN

El presente estudio tiene como objetivo determinar el comportamiento de algunos indicadores bioquímicos en la orina de atletas femeninas de sable, de edad juvenil, después de una sesión de entrenamiento, entre los que se destacan el pH (reacción), la glucosa, la albúmina y uno de los tres cuerpos cetónicos (la acetona). La muestra estuvo representada por siete atletas de sable femenino, pertenecientes a La Academia provincial de esgrima, categoría juvenil, con una edad promedio de 16 años y dos de experiencia. El estadígrafo utilizado para las comparaciones fue la media. La determinación del pH, cuantitativamente en la orina, fue a través del papel del pH. La determinación de la glucosa se realizó a través del método del reactivo Benedict. La albúmina se determinó en la orina, a través del método del ácido sulfosalicílico. Y la determinación de la acetona fue mediante el método de Imbert. La motivación para la investigación se debe a la incorporación del sable femenino en la esgrima contemporánea, lo que estudia las características y rendimiento del sexo femenino en el sable, arma bien rápida y fuerte. Los resultados demuestran cómo la carga aplicada durante una sesión de entrenamiento de un microciclo seleccionado de la preparación especial provocó variaciones en la mayoría de los indicadores, demostrando la aparición de un estado de acidosis en la orina, como consecuencia del trabajo realizado. Y se constató, además, la utilidad en la determinación de la albúmina para caracterizar la intensidad de la carga física.

Palabras clave: Indicadores Bioquímicos; pH; Glucosa; Albúmina; Acetona.



RESUMO

O presente estudo visa determinar o comportamento de alguns indicadores bioquímicos na urina de atletas do sabre feminino, de idade juvenil, após uma sessão de treino, entre os quais se destacam o pH (reação), glicose, albumina e um dos três corpos cetônicos (acetona). A amostra foi representada por sete atletas do sabre feminino, pertencentes à academia de esgrima provincial, categoria juvenil, com uma idade média de 16 anos e dois anos de experiência. A estatística utilizada para as comparações foi a média. A determinação do pH, quantitativamente na urina, foi feita através do papel de pH. A glicose foi determinada utilizando o método do reagente de Benedict. A albumina foi determinada na urina, através do método do ácido sulfosalicílico. E a acetona foi determinada pelo método de Imbert. A motivação para a investigação deve-se à incorporação do sabre feminino na esgrima contemporânea, que estuda as características e o desempenho do sexo feminino no sabre, uma arma muito rápida e forte. Os resultados mostram como a carga aplicada durante uma sessão de treino de um microciclo selecionado da preparação especial causou variações na maioria dos indicadores, demonstrando o aparecimento de um estado de acidose na urina, como consequência do trabalho realizado. Foi também confirmada a utilidade da determinação da albumina para caracterizar a intensidade da carga física.

Palavras-chave: Indicadores bioquímicos; pH; Glucose; Albumina; Acetona.

INTRODUCTION

In 1959, in Cuba, a great transformation in the economic, political and educational order became evident. These changes contributed to scientific and technical advances that made it possible to achieve an increase in productivity, as well as an improvement in the social and working conditions of the workers. That is why, since 1961, the greatest achievement in institutional matters has been the creation of the National Institute of Sports, Physical Education and Recreation (Instituto Nacional de Deportes Educación Física y Recreación) According to [Cuesta \(2018\)](#):

"Many have been the achievements and conquests of Cuban sports in all these years of the Revolution, from the massiveness achieved, community physical recreation, physical education, sports for all, to the sports results achieved in the international arena, with a large number of world and Olympic champions and medalists, who have put the name of Cuba on high. These successes of our national sport have been a guide and impulse for the development of the sports movement in Latin America".

Fencing, a combat sport with a blade, does not escape from these achievements, as many athletes of the three weapons: foil, saber and epee, have reached the podium of awards in international arenas. In order to sustain and improve these results, professionals and trainers are considering ways and methods and, at present, it is necessary to rethink formulas that, together with technological innovation, allow advances in the sporting results of this beautiful sport. In this sense, [Arkayev \(1980\)](#) pointed out:



"Regular fencing training and competitions educate and develop the ability to quickly assess the technical and tactical possibilities of opponents, increased sharpness, accuracy and speed of visual perceptions and motor reactions, a keen sensitivity and a general and specific endurance to overcome great and prolonged physical and psychological stresses" (p.4).

Meanwhile, for other authors such as **Ortiz and Gómez (2019)**:

"Fencing is an individual sport of combat and opposition. The actions take place in the presence of an opponent and the motor behaviors of both have opposite intentions. The objective of this sport is to touch without being touched, that is, to reach the target with the weapon, which is the opponent's body, before the opponent achieves it" (p.4).

As previously stated, fencing is composed of the foil, the epee and the saber. The latter, addressed in the present research, is **Arkayev (1980)** "a cutting and piercing weapon and its weight is between 325 and 600 grams and the total length is not greater than 105 cm" (p.187).

In spite of the fact that in the 1980s, sabre was still thought of only as a weapon for men and young people, in the current context, sabre is practiced by women, which gives a distinctive touch to fencing in contemporary times. Reason enough to carry, with greater motivation, dissimilar questions to improve the performance of female sabre athletes. Through the study of biochemical indicators and their variation in the urine of athletes, it is verified whether the explosiveness and speed of this weapon also allow measuring the intensity of training.

For the conduct of this research, the starting point was the need to know the response of the organism in the biochemical indicators, once the fencing training load has been carried out.

There is a close relationship between fencing and the different systems of the organism. This, together with the constant increase in the intensity of training, has led both coaches and all personnel who, in one way or another, are linked to high performance training, to seek answers to the unknowns that arise during the training process in other sciences, such as Morphology, Biochemistry and Physiology, which have helped training to have an increasingly scientific character. Therefore, it is clear that the support given to this sport by the applied sciences is indisputable, in order to know the adaptive responses that occur in relation to the applied loads.

Similar investigations that raise variation of urine indicators during physical activity, as is the case of the publication made by **Manzanares, (2015)**, as Head of Clinical Analysis Service of the Hospital General Básico de la Defensa in San Fernando, in Cadiz, Spain, with the title "Interpretation of basic urine analysis in the athlete, in the journal *Medicina de Familia*". He states that:

"Basic urinalysis is an easy and rapid method for obtaining diagnostic information on diseases primarily affecting the urinary system. However, the performance of intense physical exercise by a healthy individual can cause changes in several organs, particularly in the urinary tract. Hematuria and proteinuria are abnormalities found during sports practice, both in non-contact and contact sports" (**Manzanares, 2015, p. 1**).



The same author describes in his research result some parameters that show "non-pathological" variations, observed in dipstick and urinary sediment analysis in intense physical activity. For example, Density, pH, Protein, Glucose, Ketones, Bilirubin, Urobilinogen, Leukocytes, Erythrocytes, Flat Epithelium, Renal Epithelium Absent, Hyaline, Granular (Manzanares, 2015).

Other authors such as Peñaloza, Andrés and Gutiérrez, (2019), refer that, although the study was not with urine analysis, it also shows that the result will be available, even in the presence of the athlete and coach, in order to adapt future workloads to the individual characteristics of each athlete, improving the quality and process. In the research on biological markers, specifically CPK (creatine phosphokinase), in order to know its incidence in the practices and trainings of the female volleyball group, of the University of Cundinamarca, Soacha extension, the authors propose that the samples are quantified and measured by the Reflotron system, which yields results comparable to those obtained by standard laboratory methods, in two or three minutes per parameter; in this way, of each of these without falling into overtraining.

As can be appreciated, several authors have investigated the importance and practical utility of biochemical indicators to evaluate sports performance and improve it in athletes of various sports. Another text, which also analyzes biochemical indicators, is that of Muñoz, *et al.*, (2018), which addresses the issue of variation in urine indicators, establishing a comparison between sedentary individuals and athletes in training. The study concluded with the theory that the concentrations of the elements analyzed (magnesium and phosphorus and the trace elements arsenic, boron, lithium, cesium, rubidium, tin and strontium) are in normal ranges, therefore, there is no risk to health. Systematic training results in a lower elimination of magnesium and tin and a higher elimination of cesium, which would avoid toxicity due to their accumulation, which does not impair their performance.

Another research such as that of Campoverde (2016) seeks in the development of his study the cause of the red coloration in the urine of an athlete and, carrying out the relevant analysis, it was determined that this hue in urination would be the result of intense physical exercise performed by the patient the night before, this being a common physiological condition in athletes.

On the other hand, Álvarez and Alexandra, (2018) state that a statistical analysis was performed with the use of the t-student test for independent samples to correlate results between athletes and students. The results show that urea presents 98 % within normal parameters, creatinine 98 %, uric acid 100 %; these data are before exercise. When they were submitted to a 1-hour training, it was obtained: urea 94 %, creatinine 92 %, and uric acid 99 %. With these values, it can be said that the athlete, when submitted to a physical effort, changes his biochemical parameters because the body responds to the effects of the activation of the sympathetic system. The investigative result concludes that the athlete suffers certain alterations at renal level such as urinary tract infection and creatinine level alterations, due to several factors; one of them is the physical effort, degree of hydration and nutrition to which they are subjected.

It coincides with the criteria of the authors cited above, in relation to urine and its biochemical indicators, which are very practical and truthful when it comes to knowing the effectiveness of increasing the intensity of the physical load applied during training. In addition, it could be at whatever level the athlete is at with just a urine sample. However, on the other hand, although it can be effective, it differs from the criteria of



other authors who study the analysis of other indicators at the blood level, since the result of the research shows that the use of urine would be easier and faster to analyze, depending on the method used.

The motivation for the beginning of the present study is due to the incorporation of the female saber in contemporary fencing. Therefore, it analyzes the characteristics and performance of the female sex in the sabre, a weapon that is both fast and strong at the same time. For the realization of the research, the urine of female sabre athletes was analyzed, for which the characteristics of the renal function were previously studied. The bibliographic review reveals that the kidneys are organs in charge of filtering the substances necessary for the metabolism of the organism and eliminating the terminal products of this metabolism.

Recent research in athletes shows the impact of intense physical exercise on renal function in long-distance athletes. It is also addressed, in his research, by [Coca, \(2019\)](#), who analyzes the effect on different analytical and clinical parameters, which will serve to illustrate the adaptation of renal tissue subjected to the demands of high-intensity physical exercise in sports disciplines (athletics, triathlon, etc.).

The kidneys regulate the concentrations of mineral salts in the internal environment, so urine is a by-product of this regulation, and they participate in several phenomena due to their ability to keep the composition of extracellular body fluids moderately constant. These phenomena are:

1. Elimination of excess water either formed or introduced into the organism.
2. Elimination of non-volatile terminal products of metabolism.
3. Elimination of inorganic elements according to the needs of the organism.
4. Elimination of some abnormal substances that enter the organism.
5. Retention of substances necessary for metabolism. For example: plasma proteins, glucose, amino acids, hormones, vitamins, etc.
6. Formation and excretion of certain substances such as ammonia and hydrogen ions.

These renal functions are important in the regulation of the electrolyte balance, the osmotic pressure of body fluids. In addition, the kidneys are involved in acid-base regulation and in the elimination of metabolic products and some toxic substances.

It is characteristic in fencing, a high content of lactic acid in the blood, which cannot be eliminated and, therefore, passes into the urine, causing a high degree of acidity of the same. In this type of physical activity, there will be a large accumulation of acid products in the blood, which cause an alteration in renal activity and facilitate the elimination of substances that normally do not.

The objective of the present study is to determine the behavior of some biochemical indicators in the urine of female sabre practitioners of juvenile age, after a training session, including pH (reaction), glucose, albumin and one of the three ketone bodies (acetone).



MATERIALS AND METHODS

The empirical methods used were participant observation, which allowed witnessing and reviewing several training sessions to determine which class would be selected to apply the analysis to the urine, once the physical load was finished. The interview was applied to the athletes, with a series of questions to know their state of mind and opinion at the time of incorporating them in this research.

During the documentary analysis carried out, the necessary information was compiled, the results of other researches were reviewed, related to biochemical changes, both in urine and blood of athletes after training and a comparison was established with such researches in the same field, where biochemical indicators have been referents to analyze the loads during sports training and to know if the sports performance varies during the physical loads applied.

The consultation with specialists was useful to exchange knowledge with fencing specialists from the provincial academy and the Espa (High School of Athlete Preparation), in order to seek information to know fundamental aspects to take into account when analyzing the results in terms of athlete performance, based on the variation of urine indicators. In addition, there was an exchange with specialists in the field of biochemistry and sports medicine, in order to analyze and interpret the results of the samples obtained.

The statistician used to make the comparisons was the mean and the sample was represented by seven female sabre athletes, belonging to the provincial fencing academy, youth category with an average age of 16 years and with two years of experience. The sample of the athletes was taken in conditions of relative rest (before training) and after the end of training, in a session belonging to a microcycle of special preparation.

The training session had the following characteristics:

- Volume: 2.
- Intensity: 3.

Which corresponds to the indicators established in this sport for volume and intensity.

Initial warm-up part:

- The duration of the general warm-up was 20 minutes.
- The duration of the special warm-up was 15 minutes.

Main part of the training session:

- Individual displacement: 15 minutes.
- Plastron work: 10 minutes.
- Work in the mirror: 10 minutes.
- Individual class: 30 minutes.



- Assault of study: 60 minutes (bouts of 5 and 15 touches respectively).

Final part:

- Recovery exercise: 5 minutes.
- Collection of materials: 3 minutes.
- Training analysis: 10 minutes.
- Formation and farewell of the group: 3 minutes.

The urine samples were taken before the training session and at the end of it, using sterilized bottles prepared for the occasion, which were taken to the laboratory, where the biochemical indicators studied were determined. These were:

- pH (reaction).
- Glucose.
- Albumin.
- Acetone.

RESULTS AND DISCUSSION

The quantification of the results allows us to diagnose the different levels of physical condition and through these to plan the training and calculate and/or adjust the workloads, a fundamental and indispensable parameter in the management of the high performance athlete.

Analyzing the results obtained, it can be analyzed the results of the indicators studied, in the measurement applied in resting conditions. The average pH value of the investigated athletes is 6.8, which is considered within normal values since it should range between 6 and 7, i.e., the urine reaction is considered slightly acidic, which depends largely on the nature of the diet.

As a significant fact, the presence of glucose in urine in resting conditions appears in athlete number five; this is a matter that must occur since the resting concentrations of these substances are very low and these values are only justified by a diet very rich in carbohydrates.

Table 1 shows the behavior of the indicators studied after the end of the work; it is observed that the pH (reaction) decreases to an average value of 5.1. The presence of glucose in the urine increases in the athletes, resulting in six positive athletes and only one negative after training, as well as cases containing slight traces of albumin in the urine. However, no ketone bodies appear in the urine. (Table 1).



Table 1. - Behavior of the indicators studied after the conclusion of the work

<i>Indicators</i>	<i>Athletes</i>							
	1	2	3	4	5	6	7	X
pH (reaction)	6	6	5	4	5	5	5	5.1
Glucose	+	+	+	+	+	-	+	+
Albumin	LT	T	T	LT	LT	-	LT	LT
Acetone	-	-	-	-	-	-	-	-

Legend: Glucose + (positive); (negative); Albumin LT (slight traces) T (traces) +(cross) ++ (two crosses) - (negative); Acetone + (positive); (negative).

Figure 1 shows how the pH values (reaction) of the urine as a consequence of the load performed cause a decrease in this indicator from 6.8 as an average value to 5.1, demonstrating, to a large extent, that the loads performed in the training session have caused a state of acidosis in the organism, which is reflected in the urine. It is known that, due to physical activity, the urine tends to acidify, since it is one of the effective ways of elimination of hydrogen ions and, the more intense the work, the greater the acidosis in the blood and, therefore, in the urine (Figure 1) y (Table 2).

Table 2. - pH reaction

	pH reaction
Rest	6,8
Training	5,1

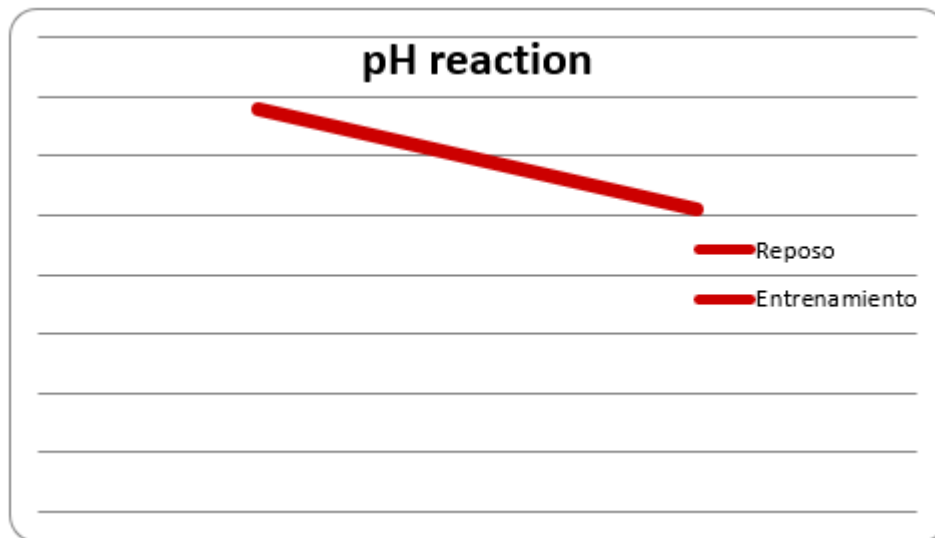


Fig. 1. - Behavior of pH reaction, in the resting state and after training



Figure 2 describes the behavior of glucose in urine during rest and after training, highlighting how, in resting conditions, a positive case (+) appears, which could have occurred by an excessive intake of carbohydrates with food, however, at the end of the session, However, at the end of the session, it could be verified by applying the Benedict's Reagent method and, once the operative technique was concluded, only one negative case was observed (one negative case with the blue sample) and of the six positive cases, it was observed that the urine coloration was (four orange and two brick red samples). This can be explained because the load caused an increase in blood glucose concentrations, due to the degradation of hepatic glycogen, which is transported by the blood and in the process of ultrafiltration in the renal glomeruli. (Figure 2) y (Table 3).

Table 3. - Positive and negative cases

	Positive cases	Negative cases
Rest	1	6
training	6	1
Total	7	7

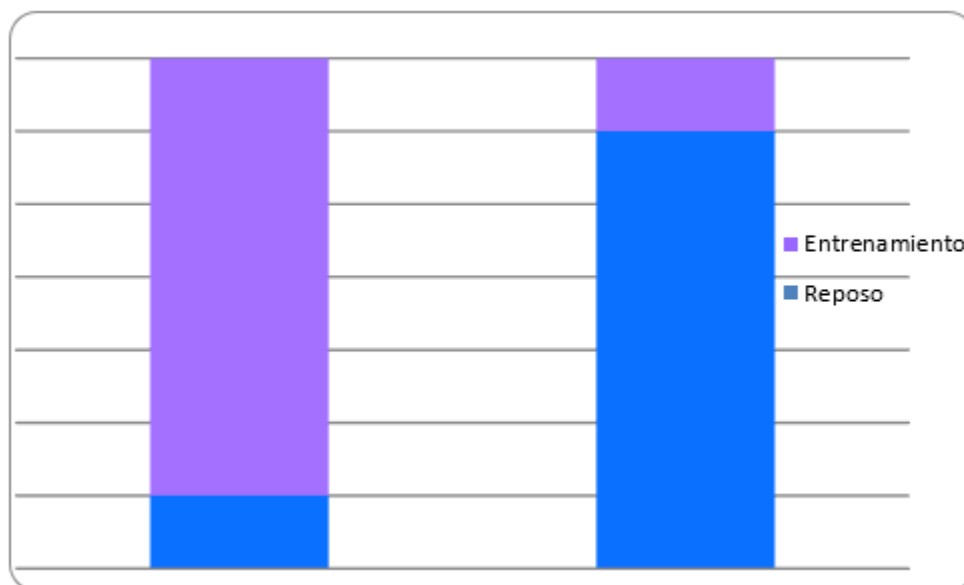


Fig. 2. - Behavior of glucose in urine during rest and after training.

It can be inferred that the biochemical variations that occur in the blood due to training are reflected in the decrease of pH in the urine and the appearance of glucose.

In the previous studies carried out on the subject of the present research, the number of articles dealing with the subject is insufficient. The research on the female sabre weapon, which began to be practiced in contemporary fencing, is new, as well as the study of the variation in biochemical indicators in athletes of this sport.



CONCLUSIONS

With the conduction of this research, it is concluded that the biochemical indicators (pH, glucose and albumin in urine) caused variation in a training session and the appearance of acetone in urine was not observed, so the hypothesis put forward in the research is accepted. In addition, as a very important fact, it was proved that the presence of albumin in urine is one of the most useful indicators to know the intensity and effectiveness of fencing training loads in female sabre athletes, juvenile category.

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Conflict of interests:

The authors declare not to have any interest conflicts.

Authors' contribution:

Yordamia Leon Santana: Conception of the idea 100 %, literature search and review 80 %, instrument making 80 %, instrument application 80 %, compilation of information resulting from the instruments applied 80 %, statistic analysis 80 %, preparation of tables, graphs and images 80 %, database preparation 100 %, general advice on the topic addressed 90 %, drafting of the original (first version) 100 %, review and final version of the article 100 %, article correction 70 %, authorship coordinadora 100 %, translation of terms or information obtained 70 %, review of the application of the applied bibliographic standard 70 %.

Rosa Cabrera Medina: Literature search and review 10 %, instrument application 10 %, compilation of information resulting from the instruments applied 10 %, statistic analysis 10 %, preparation of tables, graphs and images 10 %, article correction 10 %, translation of terms or information obtained 10 %, review of the application of the applied bibliographic standard 10 %.

Adrianna Rodríguez Elliott: Literature search and review 10 %, instrument making 10 %, instrument application 10 %, compilation of information resulting from the instruments applied 10 %, General advice on the topic addressed 10 %, article correction 10 %, translation of terms or information obtained 10 %, review of the application of the applied bibliographic standard 10 %.



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