THE ORIENTATION OF PERFORMANCE TRAINING ACCORDING TO THE BLOOD LACTATE CONCENTRATION

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Abstract

Athletic performance depends more and more of the intensity of the effort in competition. The primary effect of intensive efforts over the muscles is lactic acid, substance which, in the case of incorrect orientation of the training, returns in a reversible reaction, in to pyruvic acid, leading to reduction of the exercise intensity and calling for Krebs cycle, a specific aerobic efforts.

Aim. *Through proper training can boost correctly three of the five types of LDH, enzymes released from lactic acid ion H +, making into lactate, and never returns to pyruvic acid.The stimulation of enzymes is achieved by controlling the difficulty of training sessions. Romanian coaches „decrease volume and increase intensity" without understanding - which volume? and, - the intensity?*

Key words: *lactic acid, pyruvic acid, lactate, phosphocreatine*

THE PROBLEM

In the orientation for optimal sports performance training must take into account the intensity of the effort in competition. Intensive efforts power is supported by anaerobic glycolysis, having as a result as a final product a certain amount of lactic acid, a substance which, in the case of incorrect orientation of the training, return by a reversible reaction, into pyruvic acid, leading to reduction of effort intensity and calling for Krebs cycle, a specific aerobic efforts.

Observing that in 2012 both the EC and the Olympic Games, sportswomen from the Romanian lot accused, powerful blockages at the endings of the race, we intend to explain the causes that provoked these reactions.

The researches in this direction were made, dealing with the biochemical aspects of each specific energetic process, some refer to the anaerobic-aerobic threshold, but a close connection with sports training requirements, was presented by Carlo Vittori, coach of Pietro Mennea, Olympic champion in Moscow 1980. Even if there are things that have been made public, in romanian sports performance, very few coaches really understand how should the preparation be realized in terms of the muscular resistance to the lactate concentration.

Carlo Vittori said that in order for the muscular activity to occur for a longer period at high intensities, the dehydrogenase lactate must be properly stimulate, the enzyme that prevents lactic acid go back to the pyruvic acid.Through proper training can boost correctly three of the five types of LDH, enzymes released from lactic acid ion H +, making into lactate, and never returns to pyruvic acid. Knowing that lactate is an important secondary energy source, some of which is consumed by the muscles and the other part for the operation of organs, the control of lactic acid concentration is an important objective for a correct planning of training.

BACKGROUND

Therefore, some questions that we will try to answer in this study ascertaining, based on experimental research conducted by specialists (coaches and biochemists), but also on the practical experience gained by us. In this sense, we make a more understandable interpretation of biochemistry subtleties to those who have not mastered enough the subtleties of effort biochemistry, in planning the means of training.

There are aspects of sports training that many romanian coaches, not mastered properly, in of methodological terms, aspects that have an impact on athletes performances or teams whom they train. Such as:

1.When planning training means we must understand that with this training, we need to stimulate specific enzymes of each energetic process, in terms of capacity and power.

2. When planning training means we must know: when to start the lactacid process and how we can increase the muscle resistance to a higher concentration of lactate.

3. According to one of the training principles that says, when the competitive season is approaching, decrease the volume and increase the intensity of effort, and nobody knows how to do this.

It is perhaps, the most difficult problem of training, because with the approach in of the competition

everybody seeks the entry into athletic shape, ignoring the intensities of 85%.
The reactions that the athletes feel during intense efforts, or afterwards are different and depend on the degree of training.
The muscle pain (so-called muscle fever) are caused by the damage of the membranes myofibrils (not fibrillar rupture) which, due to lactate (which is a "salt") causes those pains, the end of intense exercise , race endings, or match.
Therefore, the lactic acid of the formula CH3-CH-(OH)-COOH, is the final waste product of anaerobic lactacid glycolysis resulting from pyruvic acid. If not properly planned training means, in terms of difficulty, to stimulate the LDH (lactate dehydrogenase), lactic acid reacts reversibly, returning into pyruvic acid.
Every musclar effort is based on the metabolism of energetic substances in three biochemical processes succeeding each other and overlap depending on exercise intensity.
After winning the Olympic title in Moscow, with Pietro Menna, coach Carlo Vittori, at the congress in Formia in 1980 presented a suggestive scheme, which we present in figure. 1.

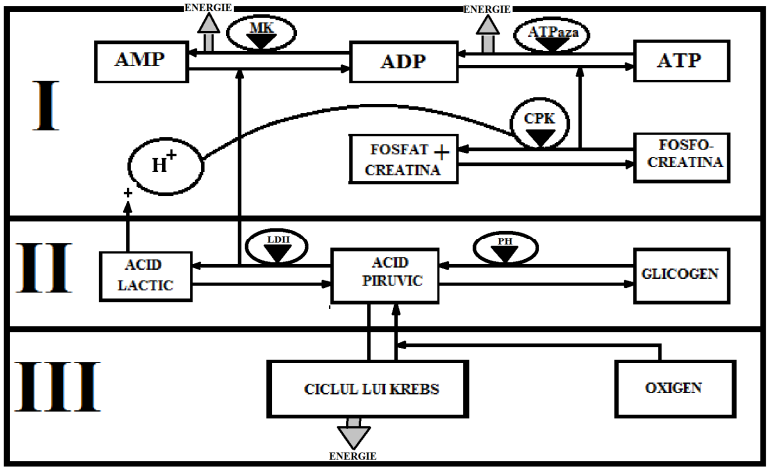

Figure 1. The links between energy processes of the muscle contraction
(Vittori, C., 1980)

By Margarita and Jons reached the same conclusion independently, lactacid anaerobic process begins when they consumed 50% of energy resources specific to the anaerobic alactacid process.
What is 50% of the energy reserves alactacide? To answer this question, let's see how these processes consist, in decreasing order of intensity and increasing of duration.
I.1. The alactacid process - Figure 1. It is known that the alactacid process can be supported depending on the level of training up to ± 10 seconds. This range is ensured by the reserves of phosphates found in muscle fibers. First, during the first 2-3s of maximal effort, occurs the cleavage of ATP existing in muscle fibers into ADP and energy, under the action of ATPase, an active enzyme to all people regardless of their training.
Maintaining maximum intensity of effort, the energy required of is provided by the cleavage of ADP into AMP under the action MK (miokinszei), enzyme which is completely inactive to the sedentary people, but which by training properly oriented, can be activated at full capacity (Carlo Vittori). Extending the effort, the energy source will be provided by phosphorus result from phosphocreatine, by CPK (creatine phosphokinase), corresponding active enzyme H + ions.
I.2. Methodological approach of training *for developing anaerobic alactacid process.* As regards of the muscular energy specific of anaerobic alactacid efforts, the exercises used will be chosen so as to fit within its specific parameters. In order as the effect to be maximum, Carlo Vittori said that exercise must first be approach in terms of capacity and then from the point of view of strength.
For increasing the capacity we mean increasing the energy reserves of the specific process, by stimulating the specific enzymes, mentioned above, in order to be able to use all of the ATP concentration present in the muscular fiber.
If ATPase continuously active for MK-ase should work exercises with maximum intensity, duration between 7s and 10s, in a volume of ± 300m, depending on age and level of training the athlete. In our experience, as athletes in the * 70 and then as a coach, we used a series of runs on range between 50m and 80m, with intensities of 96% -98% (for the control of relaxation) with

intervals of 2.30 min and 3.00 min. Carlo Vittori, in the training of Mennea, propose every 1.30 min for the efforts of 7 sec. and 2 min for the efforts 10sec. and, after determined experimentally that, in these intervals is recovering about 95-98% of the energetic substrate for the next iteration and in the series of repetitions suggests a break of recovery, about 8-10min.

For CPK the principle is the same, except that it is driven by H + ions, released from the exercises used for anaerobic lactacid capacity. *It is time that to start the lactacid process.*

Examples to develop the alactacid capacity: - 4-5x60m, 98%, aSp, i=1.30min; or: -3-4x80m, 98%, i=2.00 min; or : 2x5x60m,98%, i=1,30min, p=8min; or: - 2x4x80m, 98%, i=2.00 min, p=10min. or combinations of series of runs on 60m and 80m. These exercises should be scheduled to two days because the enzymes required for this process return to 0 in 3-4 days.

To develop alactacid power: Carlo Vittori propose for stimulating the miokinazei, the exercises of which impulse wraps around the 18/100 s, such as:
- hindering exercises for engaging a greater number of muscle fibers (squats with or without jump) and work to reduce the difference between strength and power. *Examples*: jumped step, plyometric exercises, jumping over obstacles, loaded down running, running at higher speeds (super speed), which G. B. Dintiman and R.D. Ward (1980), states that "runners manage to increase step length by ± 12.5 cm and improve time per 100 meters from an average of 10.5 seconds to 9.9 seconds.!?".

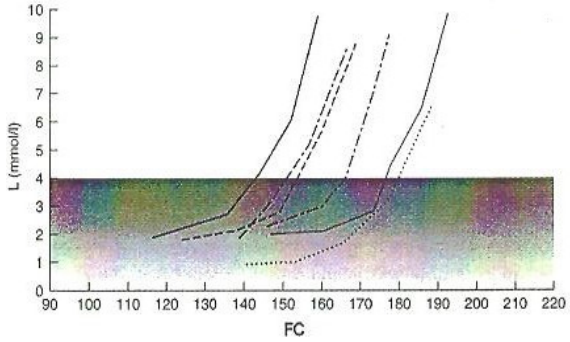

Figure 2. The variation lactate curve depending on the degree of training (GJM Peter, MD Jamson)

II.1. The lactacid process - Figure 2. After about 10 - 11s, with depleted the alactacid reserves, intense effort will be supported primarily by the lactacid, being completed by the aerobic process, at a rate depending on its length. The energetic substrate for this process is provided by glycogen, after a number of successive reactions, finally released lactic acid. From this point lactic acid constant increase to levels that the muscle no longer can support, point when the exercise intensity should be reduced, the energy resources are provided only by aerobic process. Increasing lactic acid concentration can be controlled by exercise intensity, which may provide the balance of the amount of acid released in the muscular fiber and the amount of lactate disposed in the blood at an increasing heart rate. It was determined experimentally that this balance, regardless of how it was defined stands at around 4 mmol / l.

This is not the same thing, if the balance is achieved at **a heart rate of 130 beats per minute, or if this is done over 170 beats per minute.** This is achieved if the LDH's issuing ion H + from lactic acid (CH3-CHOH-COOH), turning it into lactate (CH3-CHOH-COO-), which easily pass into the blood thus maintaining the balance of acidosis in the muscles.

II.2. Methodological approach of training for developing anaerobic lactacid process. For lactic acid not to return into pyruvic acid we need to schedule exercise with intensities between 80% and 85% of the personal time record. And in this process we must take into account what we want to stimulate the capacity or power. Here is the area where errors occur in the training lesson planning resources. One of the principles of planning training says that once the season approaches reduce the volume and increase the intensity. To avoid planning mistakes during this period, the coach should remember that:

- *develops the capacity first* and then the power;
- *in vain you train strength* unless you reached a high level of capacity development;
- *lactacid capacity* develops only through exercise with intensities up to 85% of the personal record of the moment, whose volume decreases when the competitive season is approaching;
- *lactacid power* grows through exercises performed with intensities around 98%, the volume of which increases with the approach the competitive season;
- *LDH* is stimulated by the efforts of more than 10-12 s to 60-70 s, with the intensity of more than 85%.

- *starting the effort* with intensities greater than 85%, blocks the stimulation of LDH, and then, between lactic acid and pyruvic acid may occur the reversible reaction which has been mentioned above. If this reaction takes place, then rapidly the concentration of pyruvic acid is increased, which is metabolized only by the Krebs cycle.

Examples: for lactacid capacity development. Combinations of exercises whose duration exceeds the limit of 10 s, up to about 2 min intervals between repetitions ranging from about 2 to 5 minutes.

For the preparatory period: 2x5x150m, 83% -85%, i: ~ 2.30 min, p: ~ 8-10min.; 2x5x200m, 83% -85%, i: ~ 2.30 min, p: ~ 8-10min, 200m , 300m, 400,300 m, 200m, 83% -85%, i: ~ 2.30 min, P :8-10min.

***Competitional Period*:** 5x150m, 85%, p: ~ 3min, 4x200m, 85%, p: ~ 3min, 150m, 2x200m, 150m, 85%, p: ~ 3min, etc.. This type of exercise should be maintained throughout the competitional period in order to maintain a high level of stimulation of LDH, which has a period of ± 15 days, in which would revert to 0.

To develop the lactacid power: there are used exercises performed with maximum intensity, lasting more than 10 sec. The purpose of these exercises is to increase muscle resistance to a higher concentration of lactate. Carlo Vittori recommended exercises with maximum intensity (15 s - 25 s), which allows a sufficient number of repetitions, with breaks of ± 15min, during which it was found that it removes 50% of the lactate accumulated at the end exercise. This kind of exercise increases the muscle tolerance to lactate concentration and teaches the muscle to effectively use the available energy reserves.

III.1. Aerobic process – Figure 1. Pyruvic acid is eliminated only by aerobic way through the Krebs cycle in the presence of oxygen (aerobic glycolysis). The speed at which the muscular activity occurs, energetic ensured by this process is the goal of training in the endurance sports, (long distance events). We can say, however, that the performance in the events considered aerobic, which are influenced particularly by training anaerobic processes, through the fact that events like 800 m
(M and F) by the value of the current record (?), are long gone in the anaerobic lactacid efforts.

The statements above are based on brief presentation of the three energetic processes that underlying the muscle contraction, which shows that if alactacid anaerobic process is not properly trained, then the lactacid process start in second 2, and if the lactacid process is not properly trained, it goes much faster into the Krebs cycle, which would decrease the velocity and hence the intensity of the effort, leading to poor performance.

IV. **Specific examples**. First, remember that specific enzymes to each process are stimulated by training and return to 0 after a period of between 4 and 30 days.

Before commenting on the foregoing, we present Figure 3, proposed by Issurin, V. -2008, which confirms again, the statements made by the experts cited above.

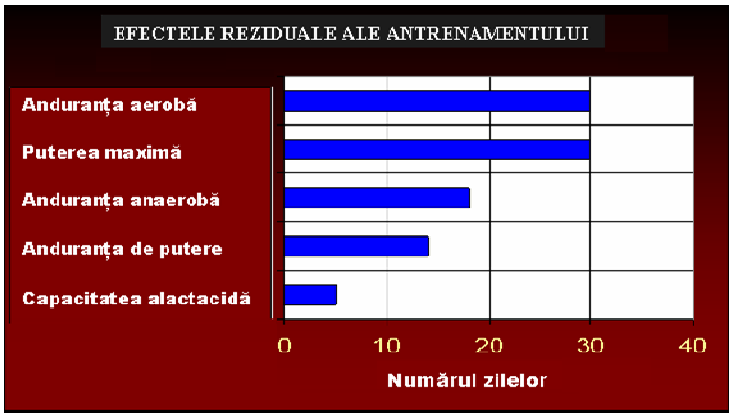

Figure 3. Residual effects of different types of training tasks (Issurin,V. - 2008)

Looking carefully the figure, we find that aerobic energetic processes activity, return to the sedentary people limits in terms of the capacity and power in ± 30 days, the activity of anaerobic lactacid energetic process returns to limits the sedentary people in terms of the capacity in the ± 18 days, and from the point of view of power in ± 14 days, and the activity of anaerobic alactacide energetic processes, it returns to the sedentary limits in ± 4 days. This means that some exercises should be made daily, others 2-3 days, but no more, for the enzymes of all processes to be activated continuously at full capacity. Only then, can we be

sure by the efficiency of the training for the power, that ensures sportive shape

From experience and our work in which we took into consideration by the statements set forth above, we believe that at present, our coaches continue to make mistakes, methodical approach to training athletes (teams) they train, reserving another large volume of specific training and a mixture of capacity and power.

IV.1. Asking the technicians in football, working for developing running speed, only with exercises on up to 30m?. We replied that it is the nature of the game!!. I replied that it is a mistaken view, because running speed depends on, - the control of the relaxation that ensures frequency, amplitude, coordination and energy economy of the running steps. Working only on short distances so, the athlete believes that doesn't tire and can run with an intensity of 100%, performing movements with low amplitudes, with times of 6/100s and that almost all the musculature of the body is blocked, and doesn't solve any of the problems previously developed.

If I asked them, why not running on distances over 60 m as recommended by the specialists in sprint and biochemistry of muscular effort, they reasoned unanimously that no football player runs in a game not more than 30 - 40 m.

Another motivation, which states the vast majority of coaches specializing in sports games is that specific way of running in the game has nothing to do with how a sprinter runs, that the sports games have contact with opponents, have the turns, game balls and other such arguments.

Those who think so (and there are many unfortunately) we address one question: - there are sports games from our country (in the which there are few players who run under 12s per 100 m) contacts and changes of direction, stronger than in the American football (where almost all the players run a hundred meters in less than 10.5 s)?.

We believe that this question, will answer those who still do not understand these issues, it actually order to streamline any exercise, even if it is running step, you must first learn correct "basic mechanism" of running step. After that, on it can be any movement structure with much higher efficiency. Unfortunately, in our country, patience and rushing for achieving performance rapidly, our coaches are making the opposite in training, first working more specific techniques, automating the inefficient techniques, difficult or impossible to correct later.

IV2. Support those shown above, with a few examples, which have obtain performances respecting as far as possible with the above principles of biochemistry, adapting them to the specific of the event (subject) in question.

We start by presenting how Paula Ivan approached training, depending on the purpose, making the difference between capacity and power in the years 1987 - 1988, preceding OJ in Seoul in 1988, which, as is known, won the gold medal at the 1500 m event, setting a Olympic record true today.

Because space does not allow us to present all notebook champion, we exemplified by several workouts lactacid and alactacid processes during competitive period.

Thus, on 05.14.1987, the same workout, anaerobic alactacid power she made - 2x5x50 m running uphill, continuing to work the anaerobic alactacid capacity, by running: 30m / 3,99 s, 50m / 6.5 and 80m/10.2, 100m/12, 8, 80m/10, 4, 50m / 6,33, 30m / 3,99. Breaks from 2 to 3 minutes.

For anaerobic lactacid capacity, on 07/28/1987, - 3 sets by 4x200 m Running tempo 29 to 30 s, the interval between repetitions consisting of 200m, jogging back and rest between sets consisting walk quietly on 200m; or - on 06.24.1988, 5x (400m + 2x200 m 62.5 s to 30.5 s) breaks and intervals as the previous example.

For lactacid power present a workout from 05/15/1987, 3 x 800 m, with breaks of 10 min. walk quietly between each repetition. Distances were completed in 2:08.4, 2:06.1, 2:03.4,!!.

VI.3. Another example was our involvement in preparing the women's volleyball team Dinamo Bucharest, coached at the time (1988) by the late Octavian Dimofte. Annoyed that many matches, in which he led 2-0, they lost 2-3, he asked for our help to solve this problem.

I asked him - "how he works the detent required for jumping to block, or attack hit? - He works lactacid capacity? - How he works for the power of attack hit?, how he is working for developing the speed?.

He said that for detent - is working running and jumping on the stair steps, jumping in different forms after the tactical and technical training - for endurance is working runs on the length of the gym (back and forth) at different distances from land lines, and twice per week , running Cooper test - for strength exercises with partner using medicine ball.

I suggested some changes, which he accepted and began thus: For detent (legs power) - I recommended to execute jumping over 10 hurdles. They started from a height of 74 cm on two legs, and they came to execute easily jumping over hurdles having a high of 91 cm on two legs and 74 cm on the strongest leg?

I explained to him, that this exercise obliges the players to perform 10 jumping at the same height (number of jumps to reach hard enough when disputing a point), which automatically transferred during matches. In the old forms, the volley-ball player wasn't performing all the jumps with the same intensity and this was happening during the game too.

For lactacid capacity they worked three times per week 5x150 m runs, with an intensity of about 80%, but the control of amplitude and relaxation, to give an image of ease and pleasure to the running,

the pause between repetitions consisting walk quietly back.

For alactacid capacity they worked every other day, timed runs, on 30m, 40m, 50m and 60m, in the total volume of more than 250m.

For the power scapular-humeral and arm they worked with medicinal ball throwing, trying each time to overcome length of the last throw.

The result was that the following year, 1990, they won the National Championship, detached from the team on second place.

IV.4. Another experience I had in the 1991-1992 when Ghita Licu (three times world champion) that coached the man's handball team of Dinamo Bucharest Club, with the example reported above, came on the stadium and used the of athletics means, starting from autumn preparatory period, he used same model of training applied on the women's volleyball team, with some small changes.

Program covered circuit system, 4x (4x50m, running the standing start, 98%, rest 2 minutes, 5x8 jumping hurdles on two feet, from dorsal decubitus 10 abdominal exercises with the medicine ball overhead throw, 200m-400m-200m, running with intensity of 80%, rest 3 minutes). This program has been worked twice or three times a week, depending on the competition program, but has not been completely neglected.

The result, was winning the National Champion title and in the EHF in semifinal Dinamo Minsk, they lost on goal difference.

IV.5. The same kind of approach to physical training has paid off to a group of tennis players, whose effort is similar to the volleyball player. Professor Vaidean, one of our colleagues asked us to assist in the physical training of a group of tennis players, I accepted, with one condition, that he will not impose such specific exercises like the back and forth, side to side or triangle, especially since they always came after technical training and spent about an hour doing these movements on the playing field. We were proposed to improve the basic mechanism of running on, as shown above, you can accommodate all types of movement.

He accepted and I began training twice a week with a very heterogeneous group in terms of age and sex. The means used was the exercises suggested in the previous examples. They were made, adapting them to each athlete according to the possibilities and peculiarities of age. With them I used exercises "super-speed" by towing. In addition to physical training exercises, observing some mistakes in biomechanics kick with the tennis racket, I have proposed a series of analytical exercises to correct these technical errors, improving the dynamic hitting of the ball.

The result was that those who left to the tournament in the circuit from March, gained double of the points accumulated throughout the year.

V. DISCUSSION

The examples presented above confirm the fact that athletic performance depends heavily on the correct approach of the means physical preparation according to the training objective.

When we set the goals for physical preparation for each workout, you should always know what you want to develop capacity or power. What kind of capacity (alactacid or lactacid)? - What kind of power (alactacid or lactacid)?

By understanding how to answer these four questions depends the level of accumulations and adjustments at every type of effort and hence the performance level.

G.J.M. Peter, M.D. Jamson, say that during endurance exercises, lactate concentration should not increase too much, because if you reach too high lactate concentration, the tolerance will increase but the endurance will decrease. About tolerance, Carlo Vittori also mentions in his presentations about how he train Mennea, when proposed starting the competitive season a workout 3-4 x150m 98% with 12-15 min breaks to increase muscle strength to the concentration lactate. About the increase of tolerance but decrease of endurance, a practical explanation gave the same Carlo Vittori, which recommends to always make the difference between capacity and power. The explanation consisting in planning the tempos in order to develop the capacity, whose intensity does not exceed 85%, which is recommended for the maximum stimulation of specific enzymes for the anaerobic lactacid effort. An increasing intensity over certain limits, reduced LDH activity and whether such training continues the activity of this enzyme can be almost completely reduced.

This phenomenon happened with athletes from the lot Romania, OJ in London - 2012 .

After the first three races of the season have achieved the best performance, at EC and at J.O. which took place in the second part of the competitive season, they accused strong muscle blockages in last part of the race.

The explanation for this drop of sportive form was strictly biochemical due to the fact that they incorrectly applied the principle that "the closer the competition is, decrease the volume and increase the intensity of your workout."

By misinterpretation of this principle, decreased totally the volume and increased intensity of all means used, including those that were designed to maintain specific enzyme activity of the lactacid capacity, increasing their rate of 90%, increasing less the volume of intensities of 98%.

This phenomenon is found more often to the sportive games, where in the competitive period the means, to stimulate specific enzymes to the alactacid and lactacid processes, are almost totally neglected. The result of this approach is manifested by the physically "fall" on the endings of our

athletes or the half of the game. This physical failure is seen even the non-specialists just watching TV.

VI.1. THEORETICAL CONCLUSIONS:

1.Lactic acid is the waste product with the greatest influence on the efficiency of the mechanical work, done by muscle contractions.

2. Muscular contraction occurs in the following three biochemical processes: the anaerobic alactacid up to about 10 seconds, the anaerobic lactacid to about two minutes and over two minutes aerobic process.

3.The alactacid process start (theoretically) after exhausted the energy guaranteed by the activity of ATPase, and MK, as the last part of the anaerobic alactacid process, the energy is provided by CPK activity, activated by H + that comes from the lactacid process.

4. In the absence of enzyme LDH, lactic acid the last waste product of aerobic glycolysis will reverse in pyruvic acid.

5. If LDH is properly activated, it acts on the lactic acid the lactate turning in lactate by removing H + ions, which itself prolongs the alactacid process and raises the threshold of anaerobic-aerobic lactate.

VI.2. CONCLUSIONS METHODICAL

1. Specific enzymes alactacide anaerobic processes (MK and CPK), is stimulated by exercises that require muscle contractions which fall within 18/100 seconds.

2. The stimulation of CPK depends on the concentration of the hydrogen ions (H +).

3. The concentration of H + depends on the level of activation of the type of LDH, which has greater activity on the lactic acid and these are stimulated by efforts lasting from 10 seconds to 2 minutes, with intensities ranging from 80% to 85%.

4. The higher activation level of LDH, higher the lactacid capacity (endurance) is.

5. Having solved the muscle endurance, is working the tolerance to the concentration of lactate, by exercises lasting more than 10 seconds, but to ensure a sufficient number of repetitions (3-4) at intervals of about 10-12 minutes.

REFERENCES

1. Dintiman, G. B., Ward, R.D.,(1988). *Sport speed*. în - Program de îmbunătăţire a vitezei. 1999. SDP 410-412.
2. Ivan, P., (2013). *Pregătirea de forţă a alergătoarelor de semifond (800 m) în etapa măiestriei sportive superioare.* Teza de doctorat.
3. Legros, L., (1980). *La biochimie au service du sprinter.* Sport Belgique.
4. Nicu, A., (1999). Teoria şi Metodica Antrenamentului sportiv. Bucureşti. Ed. Fundaţiei România de Mâine.
5. Peter, G.J.M.; Jamson, M.D., (2001). *Lactate Threshold Trening*. în – Seria: Sport de înaltă performanţă. Bucureşti. S.D.I.P. Nr. 484. 2005.