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Electrochemically Activated Water Catholyte for the Activation of Hydrogen Ions and ATP for Sport's Shape and Recovery

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Authors' contributions

This work was carried out in collaboration among all authors. Author II designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors NG and GD managed the analyses of the study. Author GD managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The biological processes of a human body occur in liquid medium. The human body contains around 55-60% of water in young people. At birth the percentage is around 75%, and in elderly people it is - 50-55% (by weight). The state of water in the body of athletes is an indicator for their status during physical exertion and recovery. Dehydration is a natural process developing during the period of training and football match, which influences the functioning of the locomotor, nervous, respiratory and cardio-vascular systems.
The research of Ivaylo Yakimov for the period 2014-2019 from Bulgarian football players confirmed the importance of the requirement for the footballers to start physical workload optimally hydrated, in order to slow down and decrease the influence of the negative effects from the inevitable

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dehydration during a football match. Yakimov is a medical doctor in the football team Ludogorets. One of the co-authors considers the possibility for hydration and recovery to be done using water with hydrogen index pH over 8.5, and a negative oxidation reduction potential (ORP). The results show that footballers, who drink Catholyte water have better heart indicators compared to the ones they would have if they drink table water. Analyses are conducted of processes in ATP and mitochondria in the cell for faster achieving of maximum sports performance and recovery.

Keywords: Water catholyte; sport shape; recovery; ATP.

1. INTRODUCTION

Research of Yakimov shows that a tendency exists for the body to have the same load in a state of hydration, as it does in a state of dehydration with smaller number of heart beats, i.e. it works more ergonomically [1,2].

The effects of free electrons in water Catholyte [2] for the increase of energetic potential of ATP and stability of hydrogen bonds are shown in the report. The improvement of the transfer of hydrogen ions through the cell membrane is analyzed. These effects are new and demonstrated for the first time in the sport preparation with water Catholyte.

Methods for spectrum analysis NES and DNES [3,4], mathematical models [5] are applied for a quantitative assessment of effects of water, nutrition additives, vitamins and minerals. Analysed is the influence of effects on the nervous system and muscle tone and anti-inflammatory, antioxidant and antitumor effects.It is applied food supplements with companies in the following countries – Bulgaria, Austria, Germany, Switzerland, Chile, the USA, Russia etc.

One of co-authors Ignatov is applying method DNES for measuring the saliva in order to estimate optimal doses of water Catholyte.

Results of the authors show that the quantity and quality of water are important for good hydration. The electrochemically activated water Catholyte has properties, which make it unique and irreplaceable for athletic shape and recovery.

The research have performed of seven football players with the following parameters heart rate, pH and ORP of Saliva, DNES spectrum of saliva.

The body draws energy from ATP in three ways [6]. Two of them are anaerobic, the third one is aerobic. The fatigue is caused by metabolic by-products. Latest scientific studies show that the reason for muscular weakness are the increase of lactic acid, the concentration of inorganic phosphate (Pi), decreased concentration of calcium (Ca^{2+}), increased concentration of hydrogen ions (H^+), and decreased concentration of glucose (Glc) [7].

According to one of the authors Ignatov the question for hydrogen ions (H^+) is open as the hydrogen displays both reduction and oxidative properties. Research of the bio effects of hydrogen in human bodyin recent years shows that hydrogen has indirect antioxidant activity over enzymes [8]. Bulgarian investigation demonstrated the presence of nascent (nuclear) hydrogen (H^*) in electrochemically activated water Catholyte, which proves the difficulty of drawing absolute consistent conclusions about the water properties [9].

In football we have 90 minutes of physical exertions requiring endurance and speed. In continuous oxidative metabolism there are two side effects [10]. Hydrogen ions (H^+) accumulate and hyperthermia is observed. The central nervous system takes part in the etiology of the fatigue from hyperthermia [11]. The dehydration during training increases the hyperthermia as it reduces the blood flow of the skin, the rate of sweating, and thus the heat dispersal. The combination of dehydration and hyperthermia during physical exertion leads to considerable reduction of cardiac tone. The blood flow towards muscles is also reduced, and thus reduces the resilience [12].

The authors examine the process of hydration and the decreased levels of hydrogen ions (H^+) as a possibility that rebuilding them may improve the sports preparation and recovery of footballers in a faster way, compared using just mountain spring and mineral waters [13,14].

Better hydration and respectively better sport shape can be achieved with waters Catholyte, Anolyte, mountain spring and mineral waters [2].

The report shows new evidence for methods to improve the transfer of H^+ ions through the cell membrane and increase of the energy reserve of ATP. The body of young people contains around 55-60% of water [15].

The authors research the influence of the doses of Catholyte water together with mineral and mountain spring waters and combinations with food additives.

2. METHODS

2.1 Physical Methods

Applied are the following biophysical methods – spectrum analysis of water and 1% solutions of saliva, waters with spectral methods NES and DNES (Antonov, Ignatov, 1998); mathematical models of water and 1% solutions (Ignatov, Mosin, 2013).

2.2 Electrical Measurements

The physical parameters pH and ORP (Oxidation Reduction Potential) of the water are measured using HANNA Instruments HI221 meter equipped with Sensorex sensors. Analysis of the infection of closely positioned pig-breeding complexes is prepared.

Range of HANNA Instruments HI221 meter:

pH - (2.00-16.00); For pH range the statistical error is 0.01

ORP (±699.9- ±2000) mV; For ORP range (±699.9) the statistical error is ±0.01 mV

For ORP range **(**±2000) the statistical error is ±0.1 mV

2.3 Device for Measurement of Hydration and Dehydration

Urine specific gravity (USG) is an accurate and rapid indicator of hydration status. A urine specimen is placed on the glass plate and study is with handheld refractometer. Normal ranges are from 1.013–1.029; a USG of ≥1.030 suggests dehydration and 1.001–1.012 may indicate overhydration [16].

3. RESULTS

3.1 Heart Rate (HR) in Recovery (Yakimov)

According to results of Ivaylo Yakimov we can define the tendency that in a state of hydration the body has the same load, as it does in a state of dehydration with smaller number of heart beats, i.e. it works more ergonomically [1].

The heart rate is monitored from the moment of refusal (impossibility to continue) to a level of 130 beats per minute (bpm). In each of the tested footballers the reaching of the indicated heart rate in hydrated condition is for the account of smaller number of beats per minute, compared to a dehydrated state (Table 1) [1,2].

3.2 Oxidation Reduction Potential (ORP) of Different Types of Waters

One of co-authors Ignatov has conducted research of water in longevity zones in Bulgarian mountains, Austrian and Swiss Alps, Chilean and Argentinean Andes, American Appalachian mountains and the Russian Caucasus mountains. These natural waters are predominantly alkaline with positive oxidation reduction potential (ORP). ORP varies between +150 до +250 mV. The hydrogen indicator (pH) provides information about water acidity. It is expressed as a negative decimal logarithm of the concentration of hydrogen ions (H^+). The oxidation reduction potential (ORP) is connected to processes with transition of electrons.

Table 1. Heart rate from the moment of refusal to a level of 130 beats per minute (bpm), H (hydration) – DH (dehydration), HR recov – bpm

Parameters⇨	DH	H
Refusal⇨	183,2	180
1`	166,8	163,2
1` 30``	155,2	151,2
2`	143,8	140,2
2`30``	135,2	132,7
3`	133,4	134
3` 30``	133,3	130
4`	129,7	125,7

3.3 Electrolyzer Chart and Reactions in Obtaining of Waters Catholyte/-Anolyte

During electrochemical activation (ECA) of water Catholyte and Anolyte are obtained in electrolyzer device (Fig. 1) [17].

The following reactions occur [18,19]:

In the cathode section of electrolyzeroccurs a reaction, as follows:

$$2H_2O + 2e^- \rightarrow H_2 + 2OH^- \quad (1)$$

The hydrogen gas is emitted and the water gains alkaline reactivity. That leads to negative values of ORP.

In the anode section the following reaction occurs

$$2H_2O \rightarrow 4e^- + 4H^+ + O_2 \quad (2)$$

That leads to increase of acidity and the anolyte's ORP is with positive values.

3.4 Heart Rate (HR) in Recovery

The heart rate is monitored from the moment of refusal to a level of 130 bpm. For all seven tested, reaching of the indicated heart rate in hydrated state is for the account of smaller number of beats per minute, compared to a dehydrated state (Table 2, Fig. 2).

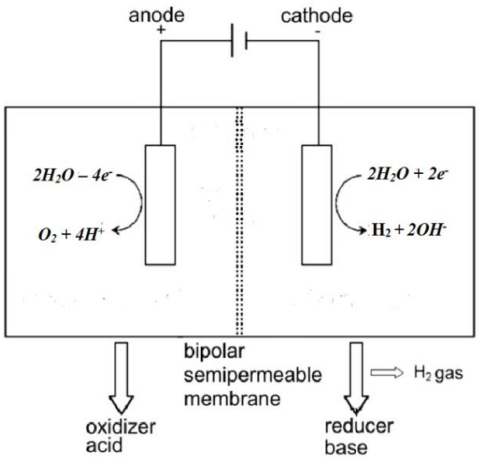

Fig. 1. Chart of electrolyzer for waters catholyte and anolyte

Table 2. Heart rate from the moment of refusal to a level of 130 beats per minute (bpm), H (hydration) – DH (dehydration), HR recov – bpm

Parameters ⇨	DH	H with table water	H with Catholyte water
Refusal ⇨	181,2	175.3	172.1
1`	165,3	157,4	154.2
1` 30``	155,4	148,1	145.1
2`	147,3	139,5	136.2
2`30``	136,6	128,4	125.5
3`	138,9	125.2	121.7
3` 30``	135,4	131.4	126.3
4`	131,5	125,7	122.5

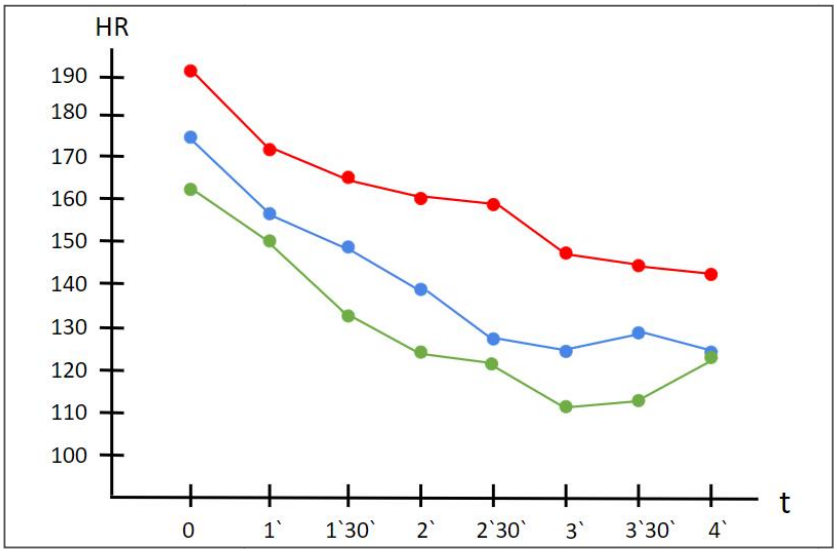

Fig. 2. Heart rate from the moment of refusal to a level of 130 beats per minute (bpm), H (hydration) – DH (dehydration), DH (red color); H with table water is with blue color, H with Catholye water is with green color, HR recov – bpm

The data for three groups are:

DH (dehydration)

1. m = 161, s = 15.8

H with table water

2. m = 141.4, s = 17.85

H with Catholye water

3. m = 130.3, s = 17.55

The coefficients of correlation are: r12 = 0.84, r13 = 0.82, r23 = 0.83

The three graphs are almost parallel, i.e. they are absolutely different.

The results of Table 2 and Fig. 2 show that the body has the same load as in a state of dehydration with a smaller number of beats per minute when hydrated. The body works more ergonomically when using Catholyte water compared to table water according to statistical analysis.

3.5 Results for Effects in Hydrogen ions Transfer and Additional Activation of ATP

One of the most unique properties of Catholyte water, proven for the first time by one of the co-authors Ignatov, is the activation of the energy potential of ATP. In hydrolysis ATP is split by water to ions and molecules. By this process the contained energy is released. The hydrolysis of ATP is described by the equation:

enzyme $ATP+H_2O \rightarrow ADP+P+H^+$

The evidence of the scientific team Nedelina, Brzhevskaya, Kaiushin from 1985 proves the relation between ATP energy and ORP [20]. During the activation of the energy balance of mitochondria and the separation of ATP electrons are accepted and accumulated. The cathode is a source of electrons for water Catholyte. It is with negative ORP, and the electrons fall within the intracellular and extracellular water [21].

The change of oxidative-recovery potential of redox-centers when energized initiates transfer of electrons in ATP-synthetase and through forming of highly reactive free radical of ADP assures availability of reaction for ATP synthesis. In such a way the energy is stored in chemical bonds.

Catholyte water alters the energy of hydrogen bonds with 0,77 – 0,95 kJ / mol [2]. The average energy of hydrogen bonds is 20-30 kJ / mol. The "wasted energy" during hydrolysis of ATP could break high number of hydrogen bonds (Xin Liu, 2013) [6]. The availability of additional energy of 0,77 – 0,95 kJ / mol and free electrons stabilize the hydrogen bonds and improve ATP synthesis. Such a difference has been demonstrated in measurements of blood serum of hamsters drinking water Catholyte and tap water. In most food additives is measured positive redox potential (REDOX) and weaker energy of hydrogen bonds.

The physical and chemical properties of catholyte and anolyte are determined for their activity.

The optimum values of catholyte for ORP are (-200 - -400 mV) and pH (8.5 – 9.5). For anolyte the values of ORP are (+500 - +600 mV) and for pH (3.5 – 4.5). Fig. 3 shows the diagram for the relation between pH and ORP, and the biosphere of micro-organisms [22].

The increased reduction of catholyte means enhanced antioxidant effect during interaction with bio-molecules. Catholyte has antioxidant and antitumor effects [23,24].

The high oxidation of anolyte has a strong biocidal impact over different microbes, bacteria and viruses, leading to retaining of their development or to their total destruction.

The durability of catholyte is up to 24 hours, and it is over 1 year for the anolyte.

One of the biggest advantages for the application of waters Catholyte and Anolyte is that the electrolyzers are portable. This allows applying the methods in competitions all over the world.

3.6 Recovery of Balance of Hydrogen Ions with Water Catholyte

During physical exetion the balance of transfer of hydrogen ions through the cell membrane is reduced. The norm is (-140 mV). Water Catholyte rebuilds this balance during the sport's load [25].

Table 3. Study of saliva after football match with table and Catholyte water

Number of football players ⇨	pH saliva before football match	pH saliva after football match	pH saliva after football match with table water	pH saliva after football match with Catholyte water
1	7.4	6.7	6.8	7.2
2	7.6	7.0	7.0	7.4
3	7.3	6.3	7.0	7.5
4	7.2	6.0	6.8	7.3
5	7.1	6.3	6.5	7.0
6	7.3	6.5	7.0	7.3
7	7.0	6.6	6.8	6.9
Average result	**7.3**	**6.5**	**6.8**	**7.2**

3.7 Research of pH, ORP and DNES of Football Players

The normal **pH** range for **saliva** is 6.2 to 7.6. The data of saliva are before and after football match. There was performed study of saliva after football match with table and Catholyte water (Table 3).

The data of saliva are before and after football match of seven football players. There has performed study of saliva after football match with table and Catholyte water.

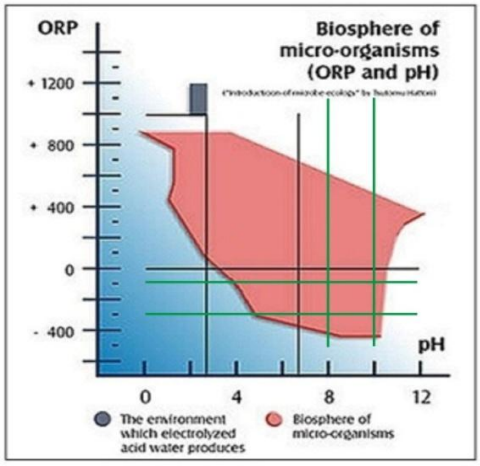

Fig. 3. Diagram for relation between pH and ORP, and biosphere of micro-organisms

The results of Table 3 show that after drinking Catholyte water the average pH result of saliva 7.3 is near to the result before football mach. Table water has difference of 0.3 of pH after sport training and Catholyte water has 0.7.

The results with oxidation reduction potential shows that the biggest difference is between saliva after football match with Catholyte water and saliva after football match. The value is (-73 mV) and difference of saliva before the match is (+5 mV).

With DNES spectrum the estimation is similar.

The conclusion is that Catholyte water hydrates optimal football players and the recovery is of shorter period of time according table water or other waters [26].

The results with Graffi tumor of hamsters influenced from Catholyte water is proof for effects on ATP and mitochondria according drinking water [27].

4. DISCUSION AND CONCLUSION

4.1 There are the Main Findings for Water Catholyte

1) The hydrogen in water Catholyte can be a reducing agent as well as an oxidizing agent. It means that a full analysis is needed of what food additives, vitamins and minerals are used by the footballer before a decision can be made of the net effects of Catholyte when combined with the diet and supplements the athlete consumes.
2) In the cathode section of the electrolyzer there is increased amount of electrons. Their quantities need to be calculated depending on the level of sports preparation and expected exertion intensity. They have influence during oxidative stress in sport.
3) The availability of additional energy of 0,77 – 0,95 kJ / mol and free electrons stabilize the hydrogen bonds and improve ATP synthesis.

4) Water Catholyte increases the energy of hydrogen bonds which improves the energy level of ATP available in the high-energy phosphate bonds.
5) For application of waters Catholyte and Anolyte in sport it is necessary to have individual approach based on the status of each sportsman, his/her diet, and the dietary supplements consumed on a regular basis.

The conclusion is confirmed for a potential resource in the work of medical and coaching teams in the professional football with regards to hydration of players with high-quality water possessing unique energetic properties. A complex method for hydration is suggested using waters – Catholyte, Anolyte, mountain spring and glacier water. The approach is individual for each footballer, and it is prepared on the basis of clinical indicators, vitality, diet, supplements and psychological status. The dosage is given depending on the sports status and the position played by the certain footballer (Yakimov, Ignatov, 2019). The method is also applicable for a combination program of water with nutrition supplements, minerals and vitamins. One of the co-authors Ignatov applies it with saliva testing.

In the climate of current conditions of highly intensive competitions and dynamics, the method is applicable also for sporting events all over the world as the electrolyzers are portable. Its applicability immediately after a game is extremely important. The recovery of 80% of the sport's form can is occurring within 3-6 hours and for over 90-95% within 24 hours (Yakimov, Ignatov, 2019).

CONSENT AND ETHICAL APPROVAL

It is not applicable.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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