

INDICES OF HUMAN URINARY EXCRETION OF THIOL AND UROCHROME IN THE ANTARCTIC AND THEIR CORRELATION TO COSMOGEOPHYSICAL FACTORS

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Abstract. The daily monitoring of the dynamics of urinary excretion of thiols and urochrome (in an individual in the extreme conditions of the Antarctic during the period of February 2001-January 2002) was executed. Similarities and differences between fluctuations in the rhythm of thiols and urochrome excretion intensity and periods of variations of a range of cosmophysical factors were discovered. It was shown that urochrome also participates in regulating antioxidant status of a body, due to common functional relation to urine thiols and due to similar influence from the cosmophysical factors. More proofs were gained that the factors of cosmophysical origin influence endogenous thiols oxidation time.

Introduction

The studies of fluctuations of unithiol oxidation time with nitrite ion [1] made in the Antarctic in 1996-1997 allowed detecting their rhythmic mode and high correlation to changes in the speed of onward and rotary movement of the Earth caused by the gravitational impact from the Sun and the Moon.

These results, being considered in the light of the ideas of thiol compounds playing a key role in biological regulation mechanisms, proved a monitor study of 'thiol status' of organism being reasonable and necessary.

The methodical approaches we engaged in the research of biochemical and biorhythmological mechanisms of an individual's adjustment to the extreme conditions of the Antarctic had two specific traits.

The first one corresponds with the role of antioxidant system in biochemical mechanism of adjustment and non-specific resistance to extreme factors of the environment, which was mentioned in the research review, and with the universal role of thiols in the functioning of this system. The second trait is defined with the following considerations: it is believed that 95% of normal color of urine depends on the presence of urochrome. The chemical structure (or content) of urochrome is not clear enough. The pigment is supposed to be a result of decomposition of the amino acid triptophane. The presence of indole structure in the molecules of the main metabolites of triptophane (indoleacetic acid, etc.) and of its derivants, for example, melatonin, gives two common features to these substances – yellow color and high oxidation capacity.

The last circumstance gave a real possibility to define a close functional chemical relation between urinary pigments and appearing of thiols in urine, which is caused by their antioxidant activity.

Therefore, the work was aimed at collecting information about functional state of the 'thiol-urochrome' system of an individual at a long-term stress and at analysis of its possible application for estimating a body antioxidant status.

The work in this direction was performed within 12 months, from February 2001 to January 2002, as a part of the 46th Russian Antarctic Expedition at the Antarctic station Vostok by one of its participants. The main task was to define sum quantity and concentration of thiols and urochrome in human urine per day and then to compare the results with cosmogeophysical data.

Guidelines

The program and method of biochemical urine test were designed on the basis of the results of a trial experiment performed in Saint Petersburg by Sokolovski V.V. and Sokolovski T.M. Concentration of thiols in urine was measured by Ellmann's spectrophotometric method [2] using calibration curve. The measuring of urochrome concentration was based on the discovered capacity of urochrome to absorb the light with the same wave length as DTNB reagent does, with the help of calibration curve to calculate thiols concentration.

We measured optical density of solutions with a photoelectric microphotocolorimeter MKMF-1 with a violet light filter (wave length 425 nm).

All the physiological samples of urine were collected and tested daily (7-8 times per day average, more than 2800 samples in total). Amount and concentration of thiols and urochrome (Σ_{sh} , C_{sh} , Σ_{ur} , C_{ur}) were measured, as well as volume of each portion of urine.

Results of the study and discussion

First we should give attention to specific characteristics of the urinary system functioning. The analysis of changes in daily amount of samples and daily urine volume demonstrates quasiperiodical mode of the changes, practically in phase 'behavior' of the curves and obvious decrease of their levels during the polar night.

Considering the obvious influence of moon phases on various functions of human body [3], we found it reasonable to analyze the dynamics of daily average values of urine samples number (n , 1/day) within synodic month (29.52 days). The fact was confirmed that n minimum appears after new moon (NM) at the first quarter of the Moon (1/4) and n maximum falls onto full moon (FM) and the third quarter (3/4), see Fig.1 (95% significance level).

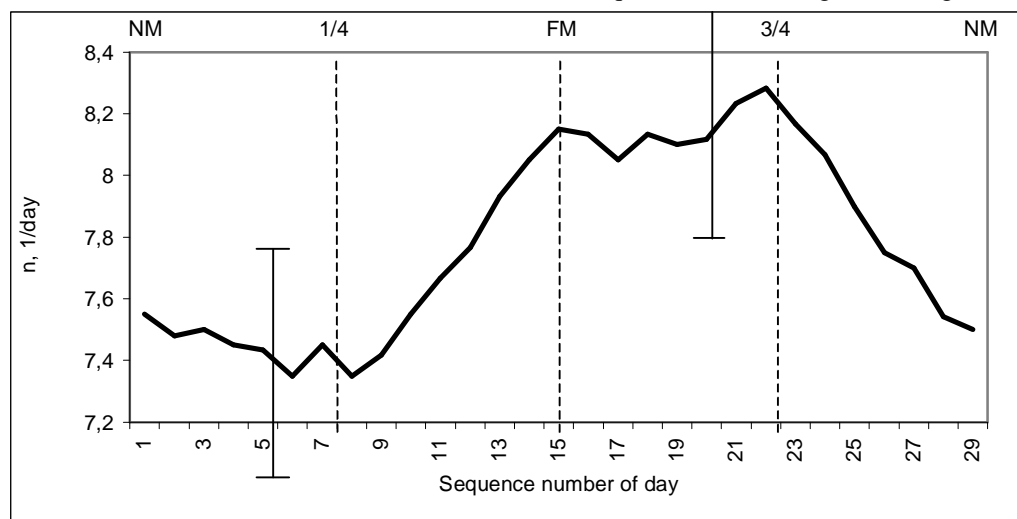


Fig. 1. Dynamics of daily average values of urine samples number (n , 1/day) within synodic month.

The analysis of the dynamics of daily average values (averaged by 9 points with sliding average technique) of the indices Σ_{sh} (C_{sh}) and Σ_{ur} (C_{ur}) during the period in question shows that total amount of thiols and urochrome excreted with urine per day and their concentrations have a noticeable positive trend. The changes make 29 μmole (35 μmole) and 15 μmole (18 μmole), respectively.

The fluctuation periods, common for all the studied biochemical indices, which are presented in Table 1, were detected with the spectral Fourier analysis.

Table 1. Periods of variations of cosmophysical factors and periodical fluctuations of biochemical indices (days).

SA and geomagnetic activity indices [4]	Disturbance from the Sun [1]	Unithiol half oxidation time [1]	Content / concentration of thiols	Content / concentration of urochrome
	14.8	15.06, 14.63	15.06 / 13.84	14.22 / 13.84
27.0 \pm 2.0		26.95	28.44 / 26.95	25.60 / 25.60
	31.8	34.13, 32.00	32.00 / 30.12	32.00 / 30.12
35.0 \pm 1.0			36.57 / 36.57	36.57 / 36.57
44.0 \pm 1.0		39.38, 42.67	42.67 / -	42.67 / -

As we can see, some of the periods are definitely close in their values to the following periods:

- of variations of solar and geomagnetic activity indices;
- of fluctuations of unithiol half oxidation time with sodium nitrite in water solutions in vitro;
- of variations of the main inequations in geocentric ecliptic longitude of the Moon caused by the disturbances from the Sun – evection and variation.

Particularly, there are rhythms of biochemical indices (13.84, 14.22, 15.06 and 30.12, 32.00 days), which are close to the periods of the main inequations – variation (14.8 days) and evection (31.8 days).

One of the rhythms of solar and geomagnetic activities, 44.0 \pm 1.0 days appears as a leading rhythm in all spectra of indices and manifests itself as harmonics with the periods of 39.38 and 42.67 days. The basic rhythm manifests itself most effectively in the fluctuations of C_{sh} (26.95 days) and C_{ur} (25.60 days). In our opinion, this fact correlates to SA maximum during 2001-2002.

Intradaily dynamics of fluctuations of Σ_{sh} , C_{sh} , Σ_{ur} , C_{ur} for all the period of the research and for the periods of polar night and polar day was also studied.

The dynamics of Σ_{sh} in all the periods is characterized with a tendency of growth during sleep hours (with the maximum point of 9,5-11 mcmmole at 6-8 a.m.), followed with a slow decrease down to 5-5.5 mcmmole by 7-9 p.m. the level of C_{sh} noticeably drops during sleep hours – from 55-57 mcmmole to 30-45 mcmmole at 4-6 a.m., then restores at awakening and slowly grows up to the maximum point (60-66 mcmmole/l), which occurs at 10-22 a.m.

We studied the results of the correlation analysis for daily average values of the biochemical indices and variations of the factors of electromagnetic origin (SA) and non-electromagnetic origin (main disturbances from the Sun to the Moon, i.e. evection and variation) and phases of the Moon. The correlation coefficients are at a low level of significance and don't exceed 0.2 in modulus.

At the same time, the dispersion of the daily average values of thiols Σ_{sh} and urochrome Σ_{ur} after reduction to the standard moon month (by counting average values of the indices for all the intervals from NM to FM) reveals a distinct relation of their levels to moon phases: high levels are detected at new moon and low levels – at full moon.

We used the method of curve polynomial smoothing (polynome of the fifth power) to separate long-period fluctuations (LPF) in the changes of Σ_{sh} , C_{sh} , Σ_{ur} , C_{ur} .

Like in the work [1], we took well-known periods describing the onward and rotary motion of the Earth, as natural analogues for the separated periods and circannian trends. The half-year wave, describing the onward motion of the Moon and the onward motion of the Earth, was calculated in accordance with ET [5, 6]. The variations, defining irregularity of the rotary motion of the Earth (a degree of the nutation in the Earth's axis with respect to the celestial pole) were received from EE for 2001-2002.

If we consider LPF of Σ_{sh} and C_{sh} and the variations of ET and EE, we can see that they change synchronously but with some phase displacement. Fig.2 gives an illustration of this fact: the changing of Σ_{sh} LPF (curve 1) falls behind the changing of ET (2). 1', 2' are the respective trends.

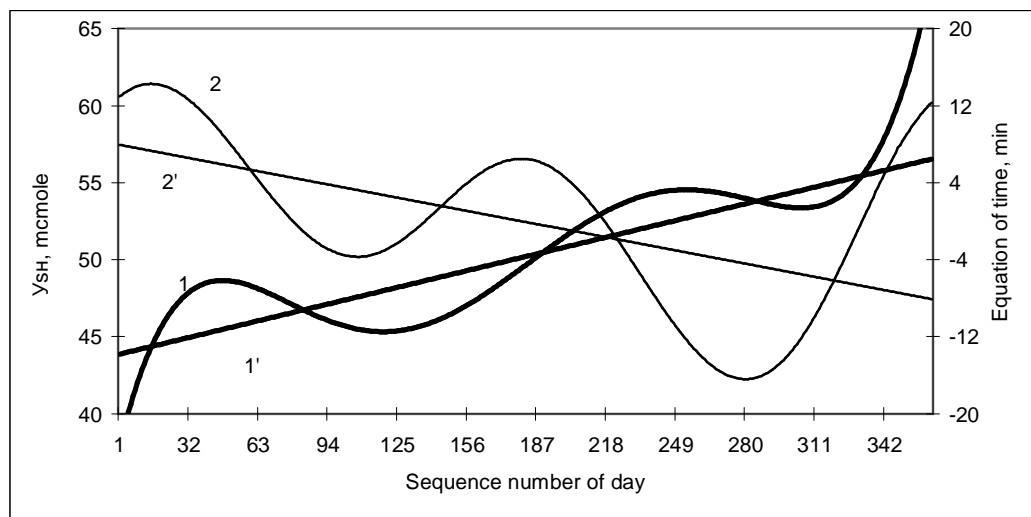


Fig. 2. Matching LPF of thiols content in urine Σ_{sh} (curve 1) and variations of ET (curve 2). 1', 2' are the respective trends.

Moreover, the displacement of ET and EE for 29 days onward increases the correlation between these processes and LPF of Σ_{sh} and C_{sh} to the largest degree. Considering ET, the correlation levels for LPF of Σ_{sh} and C_{sh} grew from 0.52 (without displacement, Pic.2) to 0.73 and from 0.26 to 0.54, respectively. Considering EE, - from 0.13 to 0.75 (for Σ_{sh}) and from 0.28 to 0.46 (for C_{sh}).

The dynamics of Σ_{ur} and C_{ur} LPF, unlike the changes of thiol indices for the same period, has a totally different origin and is determined, by most, by the season effect, i.e. appearing of a prolonged, more than 4-month, polar night in the studied period. The curves for Σ_{ur} LPF and C_{ur} LPF are well synchronized. Their maximum points are preceded with the moments of polar night beginning (the sun sets behind the horizon) and their minimum points – with the first (after a polar night) appearance of the sun above the horizon.

Therefore, growing intensity of ET and EE determines (with a phase delay) decreasing activity of oxidation processes in human body, which strengthens the body non-specific resistance and its adaptive capacities.

It is also necessary to take into account that the general tendency of activating the antioxidation protection is to some degree determined with the long adaptation period of an individual in the extreme conditions of staying at a polar station, which, according to the results of the systematic analysis of individual's physiological data, lasts 10-11 months approximately.

It can be approved with the shrinking of the misbalance in thiol indices by this moment in time, which is described by the gradually decreasing correlation (at each month interval) between Σ_{sh} and C_{sh} – from 0.6 at the first 2-3 months of living in the Antarctic to almost zero at the end of the expedition.

Conclusions

A screening analysis of thiol urinary content during the period of a long-term stay and work in extreme conditions of the Antarctic was performed for the first time (judging by the works we are aware of). These studies helped to detect a rhythmic pattern of thiol excretion and the correlation of this rhythm to the influence of a range of cosmophysical factors determining the processes of adaptation.

Looking at this phenomenon in the light of the ideas about the role that thiols play in the biochemical mechanism of antioxidation protection allows coming to the conclusion that there are periodical variations of the level of nonspecific resistance and adaptive capacities of human body, which are determined by external factors.

One of the most important results of this study is the detection of a functional relation between thiol and urinary urochrome, which gives the right to count urochrome a chemical component of urine to some degree reflecting an antioxidant status of human body.

More proofs were gained that the factors of cosmophysical origin influence endogenous thiols oxidation time.

References

1. Gorshkov E.S., Shapovalov S.N., Sokolovski V.V., Troshichev O.A. On fluctuations of reaction rate for unithiol oxidation with nitrite ion being determined with gravity// *Biophysics*. – 2000. – V.45, issue 4. – p. 631-635.
2. Ellman G. Tissue sulfhydryl groups // *Archives of biochemistry and biophysics*. - 1959. - V. 82. - P. 70-77.
3. Dubrov A.P. Moon rhythms in humans. (A sketch on selenomedicine) M.: *Medicine*. 1990. 160 p.
4. Vladimirski B.M., Temuryantz N.A.//Influence of solar activity on biosphere-noosphere. *Heliobiology from A.L.Chizhevsky to our days*. M.:MIEPU, 2000. 373 p.
5. Annual star almanac. Basic part /Ed. Abalakin V.K. – M.: Nauka Publishing. 1981. 704 p.
6. Star almanac for 1992. /Ed. Ponomarev D.N. – M.: Nauka Publishing. 1991. 352 p.