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Abstract

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A REHABILITATION EFFECT OF WATER WITH LOW SURFACE TENSION ON THE FUNCTIONAL CONDITION OF THE KIDNEYS

The aim of the research was to determine the influence of low surface tension water load on the excretory function of kidneys and the urine surface tension compared to induced diuresis by ordinary tap water.

Material and methods of research: In the experiments on 40 white nonlinear male rats weighing 0.16–0.18 kg the effect of low surface tension water load (43 dyn/cm) was studied, which was obtained by treating tap water with coral calcium (Sango Coral, Okinawa, Japan). The excretory function of kidneys was studied under the conditions of water-induced diuresis and low surface tension water loading, for which the fluids in the amount of 5% of body weight were injected into the stomach of rats with the help of a metal probe with further urine collection after 2 hours. Urinary creatinine concentrations were determined based on the reaction with picric acid. Concentrations of sodium and potassium ions were studied by using flame photometry on PFP-1. The concentration of urinary protein was estimated by the method with sulphosalicylic acid. The urine pH as well as the concentrations of titratable acids and ammonia was determined. We calculated the excretion of potassium and sodium ions, protein, titratable acids, ammonia, and ammonium coefficient. The urine surface tension was determined by the Harkinson method of stalagmometric droplet counting, based on the determination of the weight of the droplet which is detached from the capillary due to gravity.

Research results. As a result of the experiments on 40 white nonlinear pubertal male rats with induced diuresis under low surface tension water load (43 dyn/cm) compared to conventional tap water (the surface tension is 73 dyn/cm) a systemic effect was found on inhibition of the surface tension of urine from 75.00±0.000 dynes/cm to 74.05±0.260 dyn/cm ($p<0.01$), a decrease in the loss of urinary protein from 0/36±0.0074 mg/2h·100g to 0.012±0.0024 mg/2h·100g ($p<0.01$), sodium ions and the presence of significant interdependencies between the urinary surface tension, the concentrations of sodium ions and urinary protein.

Conclusion. The low surface tension water load (43 dyn/cm) compared to the diuresis induced by ordinary tap water (surface tension 73 of dyn/cm) is characterized by the systemic impact along with the inhibition of the urine surface tension (p<0.01), reduction of urinary protein losses and presence of reliable interdependencies between the urine surface tension, concentrations of sodium ions and urinary protein. Thus, the use of water treated with the Coral-mine preparation may be recommended as a rehabilitation remedy with a view of improving the functional condition of the kidneys both in health and damaged tubules of the nephron.

Keywords: water diuresis, surface tension, coral calcium, protein excretion, multifactor regression analysis.

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Резюме

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РЕАБІЛІТАЦІЙНИЙ ВПЛИВ ВОДИ НИЗЬКОГО ПОВЕРХНЕВОГО НАТЯГУ НА ФУНКЦІОНАЛЬНИЙ СТАН НИРОК

Мета роботи: з’ясувати вплив навантаження водою низького поверхневого натягу на показники екскреторної функції нирок та поверхневий натяг сечі порівняно з індукованим діурезом звичайною водогінною водою.

Матеріал та методи дослідження. В експериментах на 40 самцях білих нелінійних щурів масою 0,16–0,18 кг досліджували вплив навантаження водою низького поверхневого натягу (43 дин/см), яку отримували шляхом обробки водогінної води кораловим кальцієм (корал Санго, о. Окінава, Японія). Екскреторну функцію нирок вивчали за умов водного індукованого діурезу та навантаження водою низького поверхневого натягу, для чого досліджувані рідини в кількості 5 % від маси тіла за допомогою металевого зонда уводили щурам у шлунок із подальшим збором сечі впродовж 2 годин. У сечі визначали концентрації креатиніну за реакцією з пікриновою кислотою. Концентрації іонів натрію та калію досліджували методом фотометрії полум`я на ФПЛ-1. Концентрацію білка в сечі оцінювали за методом із сульфосаліциловою кислотою. Визначали рН сечі, концентрації кислот що титруються, аміаку. Розраховували: екскрецію іонів калію, натрію, білка, кислот що титруються, аміаку, амонійний коефіцієнт. Поверхневий натяг сечі визначали сталагмометричним методом підрахунку крапель за методом Харкінсона, в основі якого лежить визначення ваги краплі, що відривається від капіляра під дією сили тяжіння.

Результати дослідження. Навантаження водою низького поверхневого натягу (43 дин/см) порівняно з діурезом індукованим звичайною водогінною водою (поверхневий натяг 73 дин/см) характеризується системним впливом на пригнічення поверхневого натягу сечі з 75,00 ± 0,000 дин/см до 74,05 ± 0,260 дин/см ($p < 0.01$) зменшення втрат білка з сечею з 0,36 ± 0,0074 мг/2год·100г до 0,012 ± 0.0024 мг/2год·100г ($p < 0,01$), іони натрію та наявність значної взаємозалежності між поверхневим натягом сечі, концентраціями іонів натрію та білка в сечі.

Висновок. У дослідах на 40 білих нелінійних статевозрілих щурах-самцях з індукованим діурезом за умов навантаження водою низького поверхневого натягу (43 дин/см) порівняно зі звичайною водогінною водою (поверхневий натяг 73 дин/см) встановлено наявність системного впливу з гальмуванням поверхневого натягу сечі (p< 0,01), зменшенням втрат із сечею білка та наявністю достовірних взаємозалежностей між поверхневим натягом сечі, концентраціями іонів натрію та білка сечі. Таким чином, використання води, обробленої препаратом Coral-mine, може бути рекомендовано як реабілітаційний засіб з метою поліпшення функціонального стану нирок як при пошкодженні канальців нефрона, так і при нормальній функції нирок.

Ключові слова: діурез, поверхневий натяг, кораловий кальцій, екскреція білка, багатофакторний регресійний аналіз.

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Introduction

It is known that the surface tension of the water that has been treated with coral calcium (Sango Coral, Okinawa, Japan) decreases from 73 dyn/cm to 43 dyn/cm. The surface tension of intracellular water is also 43 dyn/cm [1, 2, 3]. Expectedly, there arises a question that the body's load with low surface tension water should be energetically favorable for cells, including nephrocytes, the main energy-dependent process of which is the reabsorption of sodium ions [4, 5]. At the same time, the issue of the systemic influence of low surface tension water on the organism and the excretory function of kidneys in intact animals has not been clarified to date [6, 7].

The aim of research. To find out the influence of low surface tension water load on the excretory function of kidneys and the urine surface tension compared to induced diuresis by ordinary tap water.

Material and methods. In the experiments on 40 white nonlinear male rats weighing 0.16–0.18 kg the effect of low surface tension water load (43 dyn/cm) was studied, which was obtained by treating tap water with coral calcium (Sango Coral, Okinawa, Japan). The excretory function of kidneys was studied under the conditions of water-induced diuresis and low surface tension water loading, for which the fluids in the amount of 5% of body weight were injected into the stomach of rats with the help of a metal probe with further urine collection after 2 hours. Urinary creatinine concentrations were determined based on the reaction with picric acid. Concentrations of sodium and potassium ions were studied by using flame photometry on PFP-1. The concentration of urinary protein was estimated by the method with sulphosalicylic acid. The urine pH as well as the concentrations of titratable acids and ammonia was determined. We calculated the excretion of potassium and sodium ions, protein, titratable acids, ammonia, and ammonium coefficient. The urine surface tension was determined by the Harkinson method of stalagmometric droplet counting, based on the determination of the weight of the droplet which is detached from the capillary due to gravity. The stalagmometer is a calibrated burette with an extension in the middle part with a thick-walled capillary tube with a polished tip. When determining the interfacial tension, the capillary directed downward was placed into a vessel with the fluid under test. When the drop is detached, the weight of the drop P_k is balanced by the force equal to the surface tension multiplied by the length of the capillary circle with the radius r_k, i. e. $\boldsymbol{P_k = 2 \cdot \pi \cdot r_k \cdot \sigma_x / k_n}$, where k_n is the correction factor that takes into account that the detachment of droplets occurs along the radius of the drop waist, which is smaller than the radius of the drop itself. In order not to measure the radius of the capillary rk, it was excluded by the method of comparison Sx with the surface tension of the reference liquid s0-water. Therefore, the capillary was first filled up to the mark with distilled water and the number n0 of droplets produced by water leakage was counted. Then, the capillary was filled with the same volume of the tested liquid and the number of droplets nx produced in this case was calculated. Thus, $\boldsymbol{s_x = s_0 \odot n_0/n_x}$, where s_0=73,05 dyn/cm, at an ambient temperature of 18°C at the time of the experiment, n_0=36 droplets [8, 9]. The statistical processing of the data obtained, including multifactor regression analysis, was performed on a computer using Statgrafics, Statistica, and

Excel-2003. All the experiments were carried out in accordance with the rules of work with experimental animals (1977) and the provisions of the Council of Europe Convention on the Protection of Vertebrate Animals used in Experiments and Other Scientific Purposes (18 March 1986).

Research results. The urine surface tension under the conditions of induced diuresis carried out with low surface tension water decreased compared to the load with the ordinary tap water (Fig. 1).

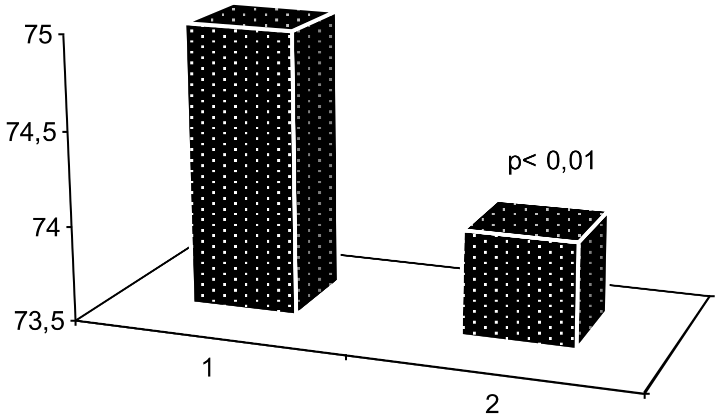

Figure 1 – The urine surface tension (dyn/cm) under water-induced diuresis conducted with tap water (1) and low surface tension water (2) treated with coral calcium (Sango Coral, Okinawa, Japan)

Under experimental conditions, it was revealed that there were no changes in the volume of urination, the concentration of potassium ions in the urine and its excretion; there was a tendency to the inhibition of the concentration and excretion of sodium ions in the urine, while the concentrations of creatinine and urinary protein and its excretion decreased (Table 1).

Table 1 – The influence of induced diuresis with the water of low surface tension on kidney function in intact rats (x±Sx)

Factors	**Tap water load – controls (n=8)**	**Low surface tension water load (n=8)**
Diuresis, ml/2h·100g	2.74±0.230	3.23±0.269
Relative diuresis, %	54.81±4.601	64.70±5.39
The concentration of sodium ions in urine, mM/l	1.52±0.51	0.86±0.229
The excretion of sodium ions, mcM/2h·100g	3.97±1.297	2.81±0.783
The concentration of potassium ions in urine, mM/l	56.4±6.48	65.5±10.64
The excretion of potassium ions, mcM/2h·100g	149.8±15.04	220.9±48.41
The concentration of creatinine in urine, mM/l	0.89±0.028	0.80±0.028 p<0.05
The concentration of urinary protein, g/l	0.014±0.0033	0.004±0.0006 p<0.01
Protein excretion, mg/ 2h·100g	0.036±0.0074	0.012±0.0024 p<0.01

Notes: p – the probability of differences from the tap water load;
n – the number of observations

The estimation of the acid-regulating function of kidneys under the conditions of induced diuresis carried out by the water with low surface tension in comparison with ordinary tap water revealed no reliable differences (Table 2).

The multifactor regression analysis revealed reliable correlations between the urine surface tension, the concentration of urine sodium ions and concentration of urinary protein under water-induced diuresis with low surface tension water in intact animals (Fig. 2).

Table 2 – The effect of diuresis induced by water with low surface tension on acid-regulating kidney function in intact rats (x±Sx)

Factors	Tap water load - controls (n=8)	Low surface tension water load (n=8)
Urine pH, units	6.4±0.09	6.3±0.11
The excretion of titratable acids, mcM/2h·100g	28.54±4.876	29.95±4.488
The excretion of ammonia, mcM/2h·100g	37.59±4.603	38.12±7.035
The ammonium coefficient, units	1.44±0.120	1.27±0.129
The concentration of hydrogen ions in urine, mcM/l	0.46±0.102	0.61±0.183
The excretion of hydrogen ions, nM/2h·100g	1.25±0.296	2.20±0.856

Note: n – the number of observations

The revealed decrease in the urine surface tension under the conditions of induced diuresis conducted by water with low surface tension compared to the load with ordinary tap water indicates the stability of the structure and the systemic impact of water treated with coral calcium.

Low surface tension water is likely to penetrate cells, including the nephrocytes of the proximal nephron, with lower energy consumption, because its surface tension is such as that of intracellular water. As a result, the energy exchange of nephrocytes in reabsorption of sodium ions and protein in the proximal tubule improves [7]. This leads to a decrease in the loss of urinary protein and causes a tendency to decrease the concentration of sodium ions in the urine. The fact that these processes are caused exactly by exposure to low surface tension water is proved by the multifactor regression analysis of reliable correlated relations between the surface tension of the urine, concentration of sodium ions in the urine and concentration of urinary protein under the conditions of induced diuresis by low surface tension water in intact animals. The decrease in the concentration of creatinine in the urine is caused by improved energy exchange of cells of the proximal nephron, aimed at greater reabsorption of sodium ions as the main energy-dependent process of kidneys and lower reabsorption of water [4, 5].

Symmetrical clusters of top water treated with the coral-mine preparation reduce the degree of erythrocytic aggregation, improve the microcirculation the delivery of oxygen to the renal tubules and stipulate the insufficiency [10, 11]. As a result of these effects the realization of the chief energy – dependent process of the renal tubules improves – the reabsorption of the sodium and protein ions in the proximal portion of the nephron both in health and in case of a damage of the proximal tubules with corrosive sublimate and 2.4 – dinitrophenol.

Moreover, the protective-rehabilitative effect of absorption in the proximal tubule may precede the form of endocytosis without substantial energy consumption, whereas unstructured water with asymmetric clusters will probably be reabsorbed via a disruption of hydrogen bonds with a subsequent reabsorption of water molecules in the proximal tubule via the channels formed by the protein – aquaporin.

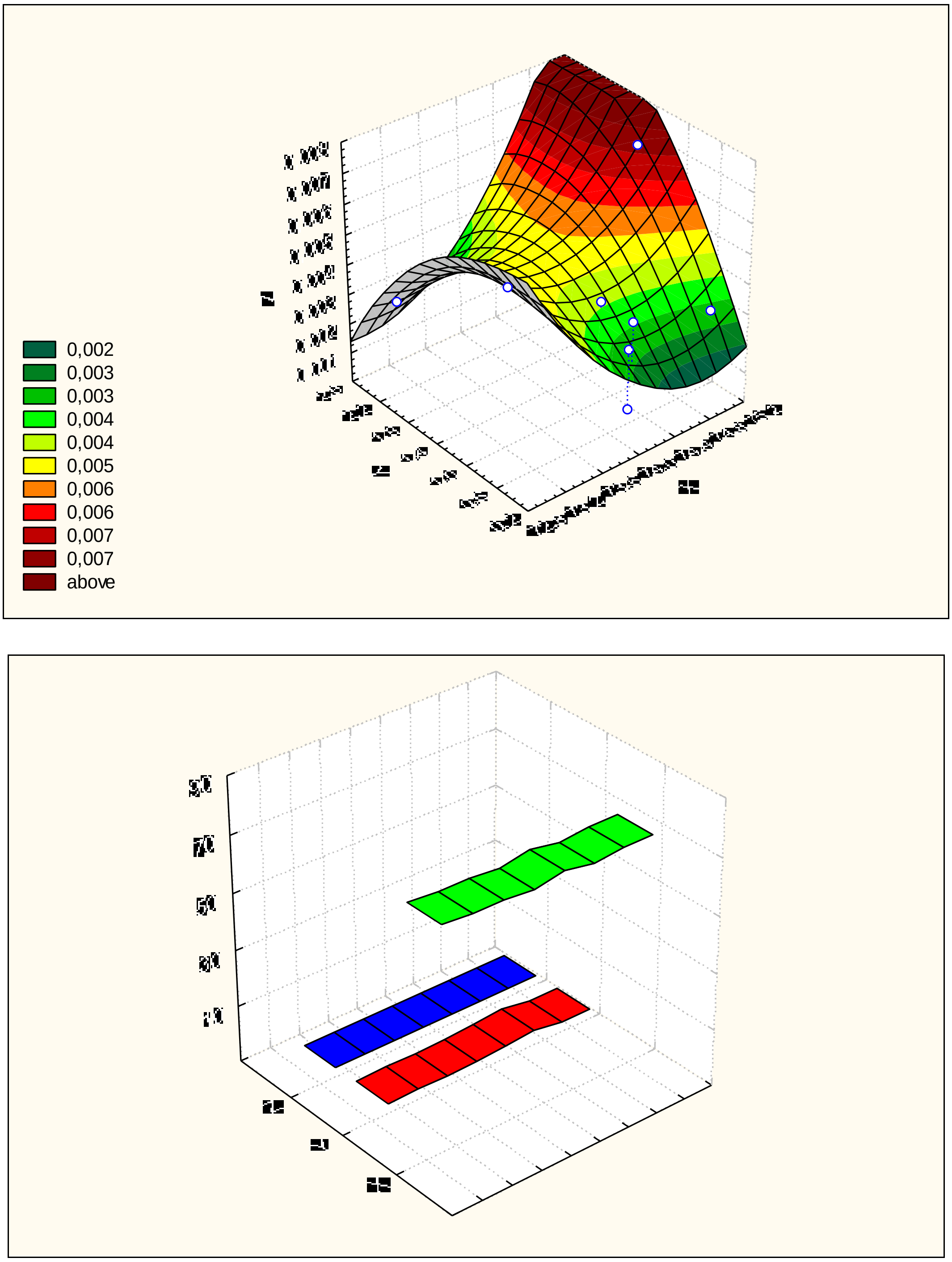

Figure 2 – The expressiveness of reliable correlated connections between the urine surface tension – X (dyn/cm), concentration of urine sodium ions – Y (mM/l) and concentration of urinary protein – Z (g/l) under the conditions of induced diuresis by water with low surface tension in intact animals. The intensity of coloration corresponds to the degree of expressiveness of the correlations

Conclusions

The low surface tension water load (43 dyn/cm) compared to the diuresis induced by ordinary tap water (surface tension 73 of dyn/cm) is characterized by the systemic impact along with the inhibition of the urine surface tension (p <0.01), reduction of urinary protein losses and presence of reliable interdependencies between the urine surface tension, concentrations of sodium ions and urinary protein. Thus, the use of water treated with the Coral-mine preparation may be re commended as a rehabilitation remedy with a view of improving the functional condition of the kidneys both in health and damaged tubules of the nephron.

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Conflict of interest

The authors declare no conflict of interest.

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