ОРИГІНАЛЬНІ СТАТТІ

UDC: 616.003.96-616.45-001.1/3-616-084

FACTOR, CANONICAL AND DISCRIMINANT ANALYSIS OF VEGETOTROPIC EFFECTS AND ACCOMPANYING CHANGES FOR THYROIDE, METABOLIC AND HAEMODYNAMIC PARAMETERS AT THE WOMEN, CAUSED BY BIOACTIVE WATER NAFTUSSYA

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In the clinical physiological observations in 30 women 32-59 years old identified multivariate vegetotropic effects of a three-week course of drinking bioactive water Naftussya spa Truskavets. It is detected that to 3/4 informations about 56 vegetative, thyroide, metabolic and haemodynamic parameters can be condensated in eight principal components. Found a strong canonical correlation between changes for parameters of heart rate variability, on the one hand, and changes for parameters of thyroide status (R=0,78), of excange of lipides and electrolytes (R=0,96) and haemodynamic (R=0,97), on the other hand. Method of discriminant analysis shows that the total of 12 selected initial parameters of the body may infallible forecast vagotonic, neutral and sympathotonic vegetotropic effects of bioactive water Naftussya.

Key words: *autonomic nervous system, thyroid hormones, cholesterol, lipoproteins, electrolytes, ATPases, haemodynamic, bioactive water Naftussya, spa Truskavets', women.*

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УДК: 616.003.96-616.45-001.1/3-616-084

ФАКТОРНИЙ, КАНОНІЧНИЙ І ДИСКРИМІНАНТНИЙ АНАЛІЗИ ВЕГЕТОТРОПНИХ ЕФЕКТІВ ТА СУПУТНІХ ЗМІН ТИРОЇДНИХ, МЕТАБОЛІЧНИХ І ГЕМОДИНАМІЧНИХ ПАРАМЕТРІВ У ЖІНОК, ВИКЛИКАНИХ БІОАКТИВНОЮ ВОДОЮ НАФТУСЯ

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В клініко-фізіологічному спостереженніза 30 жінками 32-59 років виявлено поліваріантні вегетотропні ефекти тритижневого курсу пиття біоактивної води Нафтуся курорту Трускавець. Показано, що ¾ інформації про 56 вегетативних, тироїдних, метаболічних і гемодинамічних параметрів може бути сконденсовано у 8 головних компонент. Виявлена сильна канонічна кореляція між змінами параметрів варіабельності ритму серця, з одного боку, і змінами параметрів тироїдного статусу (R=0,78), обміну ліпідів і електролітів (R=0,96) і гемодинаміки (R=0,97) – з другого боку. Методом дискримінантного аналізу показано, що за сукупністю відібраних 12 початкових параметрів організму можливу безполилкове прогнозування ваготонічного, нейтрального і симпатотонічного вегетотропних ефектів біоактивної води Нафтуся.

Ключові слова*: вегетативна нервов система, тиреоїдні гормони, холестерин, ліпопротеїни, електроліти, АТФази, гемодинаміка, біоактивна вода Нафтуся, курорт Трускавець, жінки.*

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УДК: 616.003.96-616.45-001.1/3-616-084

ФАКТОРНЫЙ, КАНОНИЧЕСКИЙ И ДИСКРИМИНАНТНЫЙ АНАЛИЗЫ ВЕГЕТОТРОПНЫХ ЭФФЕКТОВ И СОПУТСТВУЮЩИХ ИЗМЕНЕНИЙ ТИРОИДНЫХ, МЕТАБОЛИЧЕСКИХ И ГЕМОДИНАМИЧЕСКИХ ПАРАМЕТРОВ У ЖЕНЩИН, ВЫЗВАННЫХ БИОАКТИВНОЙ ВОДОЙ НАФТУСЯ

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В клинико-физиологическом наблюдении за 30 женщинами 32-59 лет выявлены поливариантные вегетотропные эффекты трехнедельного курса питья биоактивной воды Нафтуся курорта Трускавець. Показано, что ¾ информации о 56 вегетативных, тироидных, метаболических и гемодинамических параметрах может быть сконденсировано в 8 главных компонент. Обнаружена сильная каноническая корреляция между изменениями параметров вариабельности ритма сердца, с одной стороны, и изменениями параметров тиреоидного статуса (R=0,78), обмена липидов и электролитов (R=0,96) и гемодинамики (R=0,97) – с другой стороны. Методом дискриминантного анализа показано, что по совокупности отобранных 12 исходных параметров организма возможно безошибочное прогнозирование ваготонического, нейтрального и симпатотонического вегетотропных эффектов биоактивной воды Нафтуся.

Ключевые слова: *вегетативная нервная система, тиреоидные гормоны, холестерин, липопротеины, электролиты, АТФазы, гемодинамика, биоактивная вода Нафтуся, курорт Трускавець, женщины.*

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INTRODUCTION

Previously we have shown, that course of drinking bioactive water Naftussya (BAWN) spa Truskavets' (Ukraine) causes multivariate vegetotropic effects at healthy rats [9,21,32], diseased children [15] and adults women [5-8,10,11,23]. Multivariate vegetotropic effects takes place also through 80 min after the momentary use of BAWN for healthy men [33]. The purpose of this study - to find out thyroide, metabolic and haemodynamic accompaniments of multivariate vegetotropic effects of BAWN at the diseased women.

MATERIAL AND METHODS

Under a clinical physiological observations were 30 women by age 32-59 years with chronic stoneless cholecystitis in the phase of remission in combination with hyperplasia of thyroid gland. At a receipt estimated the state of the vegetative regulation by the method heart rate variability (HRV) [1-3,19,20,27], using a hardwarily-programmatic complex "КардіоЛаб+ВСР" ("ХАІ-МЕДИКА", Kharkiv). Then determined content in plasma of blood of parameters of thyroide status: thyroxine, triiodo-thyronine and thyrotropic hormone (by the ELISA method with the use of analyzer of "Tecan", Oesterreich and corresponding sets of reagents of JSC "Алкор Био", StPb, RF) [14]; lipide spectrum of plasma: total cholesterol (by a direct method after the reaction by Zlatkis-Zack [12]) and content of him in composition of α-lipoproteins (by the enzyme method by Hiller G. [29] after precipitation of notα-lipoproteins; prae-β-lipoproteins (expected by the level of triacylglycerides, by a certain meta-periodate method [12]); β-lipoproteins (expected by a difference between a total cholesterol and cholesterol in composition α-and prae-β-lipoproteins) and total notα-lipoproteins by method Burstein-Samai [12]. In the same portion plasma determined level of uric acid (by a uricase method), calcium (by a reaction with arsenazo III), magnesium (by a reaction with colgamite), phosphates (by a phosphate-molibdate method), chloride (by a mercurial-rodanide method), both in plasma and erhytrocytes determined level of sodium and potassium (by the method of flaming photometry) according to instructions [12] with the use of analyzers "Reflotron" (BRD), "Pointe-180" (USA), "СФ-46" ПФМУ 4.2 (URSS) and corresponding sets of reagents. In the suspension of shades of erhytrocytes determined activity of Na,K-, Ca-and Mg-ATPases - by the increase of inorganic phosphates in the supernatant of corresponding environments of incubation, as it is described by Makarenko E.V. [18]. The parameters of haemodynamic estimated by echocardiography method in M-regime ("Toshiba-140A", Japan) [26]. The physical working capacity (PWC_{150}) estimated by submaximal (first loading 0,5 W/kg and second loading 1,5 W/kg) veloergometric test ("Tunturi", Finland) [4].

After the three-week course of drink of BAWN (3 ml/kg, temperature of 18-20^{0}C , before 60 min to the meal three times daily) the transferred tests repeated.

Digital material is treated by methods factor, variation, canonical and discriminant analyses [30,31] with the use of package of softwares "Statistica-5.5" and algorithm of Truskavets' scientific school of balneology [4,22,24,25].

RESULTS AND DISCUSSION

A factor analysis is applied by us with the purpose of reduction of number of variables (reductions of data) determination of structure of intercommunications between variables, id est their classifications. From the row of methods of factor analysis the analysis of principal components (PC) is involved. It is considered that for the study of factor structure of the investigated field it is possible to be limited to consideration of

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such amount of PC, the total contribution of which to general dispersion of weekend of data exceeds 2/3. Other approach for determining the amount of PC is application of criteria of Kaiser (eigevalue $\lambda>1$) and Cattell (after maximal deceleration of size of eigevalue, traced graphicly) [30]. On all criteria, it appeared the optimal number of PC 8 (Table 1.).

Table 1. Factor analysis. Eigenvalues. Extraction: Principal components

N	**Eigen-value**	**% total Variance**	**Cumulated Eigenvalue**	**Cumul. %**	**Cano-nical R**
1	17,57	27,4	17,57	27,4	0,95
2	7,63	11,9	25,20	39,4	0,88
3	5,19	8,1	30,39	47,5	0,84
4	5,07	7,9	35,46	55,4	0,83
5	4,47	7,0	39,93	62,4	0,82
6	3,53	5,5	43,46	67,9	0,78
7	2,80	4,4	46,26	72,3	0,74
8	2,54	4,0	48,80	76,3	0,72

For achievement of more simple interpretation of decisions used, as known, conception of oblique (unortogonal) factors, which enables better to present the clusters of variables without abandonment from ortogonal (independences) of factors. Therefore after determination of clusters variable rotary presses of axes within the limits of clusters by us the calculation of correlations was conducted between the found oblique factors. Results, presented in a table. 2, testify for mutual independence of factors: the modules of coefficients of correlation are in an interval 0,01÷0,29 (with one coefficient 0,39 only), id est the ortogonality of factors is practically kept.

Table 2. Correlations between oblique factors (Clusters of variables with unique loadings)

F	1	2	3	4	5	6	7	8
1	**1,00**							
2	*0,26*	**1,00**						
3	*0,01*	*0,09*	**1,00**					
4	*0,16*	*0,05*	*0,04*	1,00				
5	*-0,02*	*0,20*	*0,11*	*0,11*	**1,00**			
6	*0,12*	*0,11*	*0,29*	*0,17*	*0,19*	**1,00**		
7	-0,39	*-0,14*	*0,12*	*0,05*	*-0,02*	*0,04*	**1,00**	
8	*0,17*	*0,22*	*-0,16*	*-0,21*	*0,13*	*-0,06*	*-0,22*	**1,00**

Table 3. Factor Loadings (Equamax normalized). Clusters of loadings, those determine the oblique factors for hierarchical analysis changes of parameters

Changes for Variables	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**
Stress index Baevskiy	**,959**							
Contractility index	**,953**							
Index of vegetative balance	**,940**							
Amplitude of moda	**,929**							
Variative swing	**-,895**							
Cardiac output	**,888**							
Type of circulation	**,873**			-,307				
Index adequaticy of regulation	**,864**						-,331	
Shock volume	**,854**					,262	,259	
Ejection fraction	**,850**			-,410				
Enddiastolic volume	**,847**					,258	,308	
Vegetative index of rhythm	**,830**					-,325		
HRV Triangulary Index	**-,824**			-,274				
General resistance of periferal vessels	**-,818**			,433				
SDNN	**-,789**				,369			
Total power HRV	**-,701**				,493			
pNN 50	**-,639**	-,536						
RMSSD	**-,613**	-,528					,301	
Chloride	**,566**						,265	,274

HF HRV	**-,564**	-,549	,289		-,345			
Thyroxine		**,824**						
Triiod-thyronine		**,820**						
LF/HF		**,805**						
HDL cholesterol		**,770**						
LFnorm HRV	,397	**,753**			,331			
HF% HRV	-,400	**-,650**	,264		-,404			
LF% HRV	,450	**,586**	,496					
LF HRV		**,531**	,431					
LDL cholesterol		**-,517**	,417			,394		
Na,K-ATPase		**-,320**		,313				,293
VLF% HRV			**-,834**					
Potassium of erhytrocytes			**,714**					-,483
Phosphates			**,528**		,429		,425	
Thyrotropic hormone			**-,456**	,311				
Potassium			**,437**			,308		-,346
Mean blood pressure	,446			**,827**				
Systolic blood pressure	,282			**,754**				
Endsystolic volume	-,528			**,718**				
Diastolic blood pressure	,518			**,710**				
Working Mean blood pressure					**,824**			
Working Systolic blood pressure					**,781**			
Working Diastolic blood pressure					**,700**			
VLF HRV	-,386		-,487		**,613**			
Physical Working Capacity						**,751**		
Working Heart Rate						**-,688**		
Ejection time						**,676**	,490	
Sodium						**,660**		-,322
Sodium of erhytrocytes				,326		**,633**		
Mg-ATPase						**-,528**		
Calcium				,382		**,520**	,345	-,313
Moda HRV	-,313						**,745**	
Magnesium						-,329	**,628**	
Ca-ATPase	-,314		,260				**,403**	
Uric acid								**-,722**
VLDL cholesterol		,270						**,675**
Notα-Lipoproteines			,440	-,411			-,342	**,448**
Explained Variance	**16,8**	**6,97**	**4,50**	**4,63**	**5,21**	**4,38**	**3,39**	**2,89**
Prp.Total	**0,26**	**0,11**	**0,07**	**0,07**	**0,08**	**0,07**	**0,05**	**0,045**

With the purpose of being of matrix of factor reflection, the nearest to the simplest ideal structure, procedure of ortogonal rotary press is conducted by the methods of quartimax, varimax i equamax. We are choose the method of equamax, which combines properties of two first.

Evidently (table. 3), that first PC explains the maximal part of changeability of the informative field and can be interpreted as the changes of vegetative (autonomic) regulation of haemodynamic. It is important, that maximal factor loadings gives stress index by Baevskiy as the integral marker of autonomic regulation [1-3] and contractility index by Popovych as the integral marker of contractile activity of myocard [4].

Second PC characterizes influence of thyroide hormones and autonomic regulation on HDL cholesterol level and Na,K-ATPase activity [4].

According to various authors, the power VLF component (range 0,04÷0,003 Hz) HRV reflects humoral regulation (renin-angiotensin-aldosterone system, circulating catecholamines), cerebral ergotropic effects on subordinate level, the state of neuro-humoral and levels of metabolic regulation and can be used as a reliable marker of the degree of autonomous communication (segmental) levels of suprasegmental regulation of blood circulation, including the pituitary-hypothalamic and cortical levels [1,2,20]. Other authors [16,19] link PSD of VLF with sympathetic activity. There is speculation that the formation of oscillation in the range of 0,007÷0,003 Hz associated with the activity of the hypothalamic centers suprasegmentary autonomic regulation that generate rhythms transmitted to the heart via the sympathetic nervous system. Assume the relationship VLF rhythms of thermoregulation, asked hypothalamus. Discovered rhythms associated with oscillation blood level of renin (0,04 Hz), epinephrine (0,025 Hz), norepinephrine (0,002 Hz), 17-OCS (0,0019 Hz) [17]. Thus, third PC is interpreted as autonomic and hormonal influence on exchange of potassium and phosphates.

Fourth PC characterizes changes of basal blood pressure with participation of Na,K-ATPase, intracelular sodium and extracelular calcium.

Fifth PC characterizes autonomic regulation changes of blood pressure during veloergometric test.

Sixth PC represents the physical working capacity, calculated by parameters of veloergometric test, as well as parameters of exchange of electrolytes participating in regulation of haemodynamic [4].

Seventh PC is constrained, from one side, with parameters of HRV and hemodynamic, and from other - with parameters of exchange of calcium, magnesium, chloride and phosphates.

Finally, eighth PC combines changes content in blood of uric acid, VLDL cholesterol and electrolytes.

Pays attention on itself, that content in plasma of notα-Lipoproteines, as well as, potassium, phosphates Ca-ATPase and Na,K-ATPase activity any is closely unconnected with any PC, carrying out here the minimum loading on 3-4 among them.

Thus, to 3/4 informations about changes of 56 vegetative, thyroide, metabolic and haemodynamic parameters can be condensated in eight principal components.

Than from matrix for oblique factors picked out great number of ortogonal factors dividing changeability of variabels on related to general variance (Secondary factors) and on separate variances related to clusters or similar variabels (Primary factors).

It is educed (table. 4) that exist two groups of parameters influenced by two hypothetical general factors are not measured directly. The first general factor (S 1) influences on 17 parameters of vegetative regulation, 3 thyroide, 7 hemodynamic and 6 metabolic parameters. The second general factor (S 2) has the maximal loading from changes parameters of exchanges of electrolytes. This general factor unites also changes parameters of veloergometric test and hemodynamic. Thus, due to a factor analysis it was succeeded to educe 2 independent clusters of parameters, bound by inter se causal functional connections.

Table 4. Secondary (S) and Primary (P) Factor Loadings

Changes for variables	S 1	S 2	P 1	P 2	P 3	P 4	P 5	P 6	P 7	P 8
Index adequaticy of regulation	**,548**	,139	**,714**	-,023	,159	,101	-,158	-,043	-,204	,036
Moda HRV	**-,525**	-,013	-,179	-,004	,055	-,087	-,084	-,037	**,619**	-,032
RMSSD	**-,521**	-,208	-,466	-,409	,093	,094	-,101	-,066	,186	,212
pNN 50	**-,513**	-,185	-,496	-,421	,162	,160	-,161	-,062	,095	,204
HF HRV	**-,493**	-,175	-,427	-,439	,299	,091	-,293	-,050	,077	,216
HF% HRV	**-,490**	-,160	-,266	-,543	,270	,113	-,354	-,013	,102	,148
Stress index Baevskiy	**,466**	,141	**,829**	-,036	,037	,110	,006	-,156	-,038	-,127
Cardiac output	**,466**	,115	**,760**	-,142	-,041	-,158	,002	,189	,093	,159
LFnorm HRV	**,456**	,317	,259	,635	-,014	-,026	,263	,009	-,115	-,215
Amplitude of moda	**,437**	,219	**,801**	,072	,149	,031	-,139	-,023	,059	-,077
LF/HF	**,436**	,249	,146	**,699**	,226	-,040	,063	-,120	-,079	-,003
Type of circulation	**,425**	,069	**,759**	-,040	-,038	-,315	-,083	,159	,128	,050
Vegetative index of rhythm	**,405**	,003	**,726**	-,231	,057	,203	,050	-,331	-,130	-,041
HRV Triangulary Index	**-,402**	-,144	**-,710**	-,099	,223	-,254	,079	,032	-,048	,163
General resistance of periferal vessels	**-,387**	-,083	**-,712**	-,017	,003	,444	-,018	-,126	-,057	,123
Contractility index	**,386**	,116	**,845**	-,134	,050	,127	-,013	-,176	,072	-,076
Index of vegetative balance	**,370**	,135	**,834**	-,102	,106	,139	,002	-,229	,069	-,113
VLDL cholesterol	**,368**	-,179	-,115	,223	-,066	-,019	,046	-,125	-,057	,585
Magnesium	**-,368**	-,179	-,123	-,121	-,146	,142	,074	-,283	,548	,162
LF% HRV	**,363**	,326	,333	,484	,450	,088	-,228	-,081	-,111	-,096
Ejection fraction	**,337**	,049	**,759**	-,050	-,119	-,416	,022	,160	,274	,006
Shock volume	**,321**	,162	**,759**	-,080	-,079	-,248	,068	,218	,330	,069
Uric acid	**-,321**	,019	-,163	,032	-,037	,160	-,080	-,148	-,194	-,655
Variative swing	**-,305**	-,116	-,808	,156	,047	-,170	-,148	,232	-,120	,173
Triiod-thyronine	**,302**	,153	-,001	**,749**	-,163	,104	-,085	,033	,123	,058
Ca-ATPase	**-,301**	,087	-,244	-,010	,227	,162	-,152	,040	,326	,213
Endsystolic volume	**-,289**	,153	-,466	,036	,176	**,692**	,010	-,195	-,128	-,081
SDNN	**-,262**	-,075	-,714	,122	-,067	-,168	,395	,064	,063	,224
Chloride	**,258**	,111	,492	,081	-,002	-,087	-,200	,181	,322	,230

Notα-Lipoproteines	**,236**	-,027	,005	-,211	,457	-,405	-,009	,130	-,284	,398
Thyroxine	**,233**	,053	-,122	**,777**	-,037	,046	-,120	-,135	,195	,185
Total power HRV	**-,187**	-,049	-,647	,073	-,107	-,094	,511	,050	,029	,252
Thyrotropic hormone	**,179**	-,116	,070	,030	-,423	,331	,016	-,054	,034	,188
Sodium	,109	**,477**	,154	,167	,000	,004	,143	,547	-,080	-,304
Potassium of erhytrocytes	-,163	**,464**	,215	,026	,613	,038	,089	-,008	,069	-,411
Calcium	-,112	**,419**	,195	,146	-,109	,314	-,131	,424	,298	-,255
Mg-ATPase	-,103	**-,373**	-,147	-,180	-,172	,031	,100	-,439	-,071	,024
Mean blood pressure	,123	**,364**	,388	-,067	,002	**,771**	,050	-,013	,142	-,004
Potassium	-,070	**,347**	,111	,059	,364	-,282	,168	,228	,014	-,302
Diastolic blood pressure	,213	**,342**	,438	,056	-,090	,658	-,033	,079	,199	,055
Sodium of erhytrocytes	,160	**,338**	,005	,030	-,139	,274	,076	,552	-,007	,191
Working Mean blood pressure	,125	**,323**	,110	,003	,036	,063	,775	,015	,056	-,032
Phosphates	-,095	**,317**	,067	,023	,461	,172	,393	-,195	,387	,193
Working Systolic blood pressure	-,060	**,300**	,015	-,082	,128	,074	**,745**	-,049	,148	-,052
Physical Working Capacity	,002	**,294**	-,144	-,060	,083	-,139	-,040	**,682**	-,173	,009
Working Diastolic blood pressure	,217	**,287**	,143	,060	-,025	,058	**,650**	,056	-,021	-,017
Enddiastolic volume	,277	**,278**	,755	-,086	-,018	,005	,092	,189	,363	,051
Systolic blood pressure	-,016	**,265**	,266	-,237	,097	,713	,166	-,191	,014	-,123
VLF% HRV	,074	**-,265**	-,060	,068	**-,778**	-,203	,307	,105	,067	-,045
LDL cholesterol	-,097	**,260**	,161	-,528	,360	-,096	,152	,335	-,143	-,076
LF HRV	,133	**,257**	-,193	,480	,387	-,070	,090	,012	-,023	,115
Working Heart Rate	,047	**-,238**	,044	,261	,030	,089	-,065	**-,633**	,095	-,010
Ejection time	-,160	**,203**	-,129	,038	-,183	-,239	,104	**,630**	,441	,214
HDL cholesterol	,073	**,199**	-,046	**,735**	,097	,010	-,184	-,045	,231	-,105
Na,K-ATPase	-,062	**-,112**	,059	-,296	-,155	,330	-,050	-,072	,195	,296
VLF HRV	,044	**-,073**	-,389	,196	-,470	-,142	**,622**	,090	-,010	,100

As expected, after the completion of drinking BAWN autonomic regulation parameters in various women varied in different ways. In particular (Table 5), the integral parameter autonomic regulation stress-index Baevsky in 10 women declined by 41%, indicating that for vagotonic vegetotropic effect of BAWN. In 9 women significant changes stress-index not found (neutral vegetotropic effect), and in 11 patients stated sympathotonic vegetotropic effect, as evidenced by an increase in stress-index by 74%.

Table 5. Parameters Baevskiy HRV before and after drinking BAWN and their direct differences. Significantly changes marked #

Variables	Effects	Vagotonic (10)			Neutral (9)			Sympathotonic (11)		
	Params	Before	After	Δ	Before	After	Δ	Before	After	Δ
Stress index Baevskiy,	X	128	75	-53	116	111	-5	72	125	+53
(AMo/2•Mo•ΔX), units	±m	15	9	$15^{\#}$	11	12	3	9	17	$10^{\#}$
Amplitude of moda	X	43,5	33,4	-10,1	45,6	43,2	-2,3	33,5	39,8	+6,3
(AMo), %	±m	1,6	2,8	$2,1^{\#}$	1,3	2,0	1,4	2,2	2,6	$2,0^{\#}$
Variative swing	X	204	263	+59	231	224	-7	273	209	-64
(ΔX), ms	±m	11	12	$14^{\#}$	12	11	5	10	14	$9^{\#}$
Moda	X	898	907	-9	895	910	+15	921	848	-73
(Mo), ms	±m	52	58	24	35	24	22	55	45	37
Index of vegetative balance	X	221	137	-86	203	198	-5	127	203	+76
(AMo/ΔX), units	±m	17	17	$15^{\#}$	14	16	7	12	21	$15^{\#}$
Vegetative index of rhythm	X	5,8	4,4	-1,4	5,0	5,1	+0,1	4,2	6,1	+1,9
(1/Mo•ΔX), units	±m	0,5	0,3	$0,5^{\#}$	0,4	0,4	0,1	0,3	0,5	$0,3^{\#}$
Index adequaticy of regu-	X	50	38	-12	52	48	-4	38	49	+11
lation (AMo/Mo), units	±m	4	4	$4^{\#}$	3	3	2	4	5	$3^{\#}$

Similar dynamics or lack thereof ascertained for other index' Baevsky: index of vegetative balance, vegetative index of rhythm and index adequaticy of regulation. This vagotonic vegetotropic effect is a consequence of reduced marker of sympathetic tone amplitude of moda 23% combined with an increase in parasympathetic tone marker variative swing by 29% in the absence of changes moda. Conversely, sympathotonic vegetotropic effect is a consequence of increasing AMo by 19% and reciprocal decrease in

ΔX 23%, and the tendency to sympathotonic shift of moda by 8%. The reciprocality of autonomic regulation has long been known [28,34].

Similarly, but somewhat less clearly change under the influence of BAWN and temporal indicators (Time Domain Methods) HRV (Table 6).

Table 6. Temporal HRV indices before and after drinking BAWN and their direct differences

Variables	Effects	Vagotonic (10)			Neutral (9)			Sympathotonic (11)		
	Params	**Before**	**After**	**Δ**	**Before**	**After**	**Δ**	**Before**	**After**	**Δ**
HRV TI,	X	10,1	14,1	+4,0	10,6	10,1	-0,6	13,9	11,0	-2,9
units	±m	0,7	1,2	1,2#	0,4	0,6	0,5	1,1	0,8	0,5#
SDNN,	X	47	60	+13	45	50	+5	61	51	-10
ms	±m	3	4	4#	2	3	3	4	6	4#
RMSSD,	X	25	41	+17	25	30	+4	35	25	-10
ms	±m	4	8	7#	2	3	3	5	3	5#
pNN_{50},	X	3,4	21,1	+17,7	5,2	8,7	+3,6	14,9	6,0	-8,8
%	±m	0,8	7,9	7,4#	1,5	2,1	2,1	2,5	1,8	4,8

In particular, triangular index (HRV TI) in vagotonic effect is increased by 40%, while sympathotonic effect is reduced by 21%. The standart deviation of all NN intervals (SDNN), the square root of the mean of the sum of the squares of differences between adjacent NN intervals (RMSSD) and the percent of interval differences of successive NN intervals greater then 50 ms (pNN_{50}) increased by 28%, 68% and 420% with vagotonic effect and reduced by 16%, 29% and 59% at sympathotonic effect of BAWN. When neutal vegetotropic effect changes in these parameters unreliable.

Among the spectral parameters (Frequency Domain Methods) HRV (Table 7) clear reciprocal changes in alternative vegetotropic effects, as well as their absence in neutral vegetotropic effect relation is found relative (% of total) power spectral density (PSD) of high-frequency (HF, range 0,4÷0,15 Hz) and low-frequency (LF, range 0,15÷0,04 Hz) components of HRV, and, of course, LF/HF ratio and LFnorm. Among the absolute (in ms^2) PSD this provision applies only to HF component. However, both relative and absolute PSD of very low frequency (VLF, range 0,04÷0,003 Hz) component is significantly increased in neutral vegetotropic effect and does not change when alternative vegetotropic effects.

Table 7. Spectral HRV parameters before and after drinking BAWN and their direct differences

Variables	Effects	Vagotonic (10)			Neutral (9)			Sympathotonic (11)		
	Params	**Before**	**After**	**Δ**	**Before**	**After**	**Δ**	**Before**	**After**	**Δ**
HF, ms^2	X	273	1352	+1080	255	275	+20	773	238	-535
	±m	57	431	396#	38	38	43	269	37	252#
LF, ms^2	X	1152	1002	-150	1074	986	-88	1418	1162	-256
	±m	191	111	220	170	182	187	260	141	165
VLF, ms^2	X	1042	1642	+600	658	1197	+539	1999	1725	-274
	±m	212	468	419	84	150	184#	421	706	608
Total power	X	2446	3997	+1531	1986	2458	+471	4190	3125	-1065
(TP), ms^2	±m	286	432	502#	170	263	268	475	789	661
HF, %	X	11	32	+21	14	12	-2	18	9	-9
	±m	2	9	9#	2	2	3	6	1	6
LF, %	X	48	29	-19	51	38	-13	35	47	+12
	±m	7	6	6#	6	5	6#	6	5	6#
VLF, %	X	41	39	-2	35	50	+15	47	44	-3
	±m	5	7	7	5	4	6#	6	5	7
LF/HF	X	5,6	2,5	-3,1	5,1	4,0	-1,2	4,0	5,7	+1,7
	±m	1,3	0,9	1,4#	1,1	0,9	1,3	1,1	0,8	0,6#
LFnorm	X	77	55	-23	78	76	-2	69	83	+14
%	±m	5	9	10#	5	4	6	7	2	6#

The screening of relationships between changes for spectral, on the one hand, and temporal and Baevskiy, on the other hand, parameters of HRV showed the following. Closely linked markers of vagale tone changes (Figures 1,2,3).

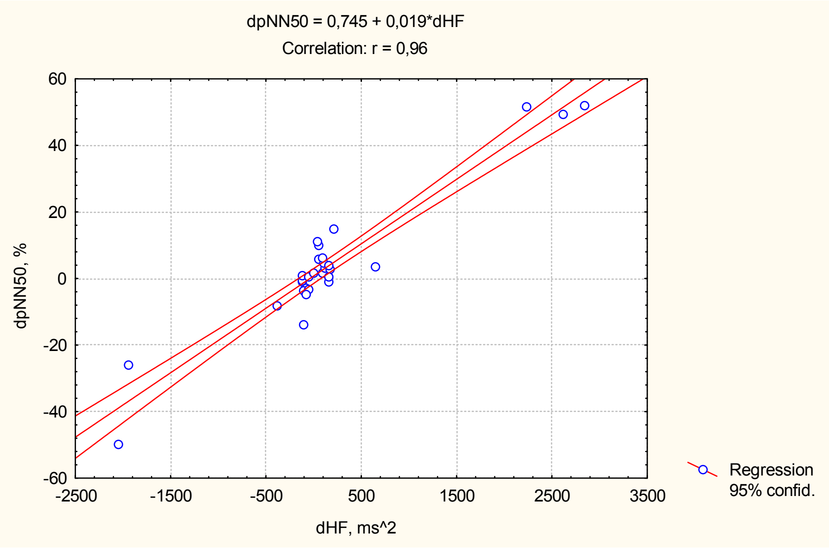

Figure 1. Correlation between changes for HF (axis of X) and pNN_{50} (axis of Y) parameters of HRV

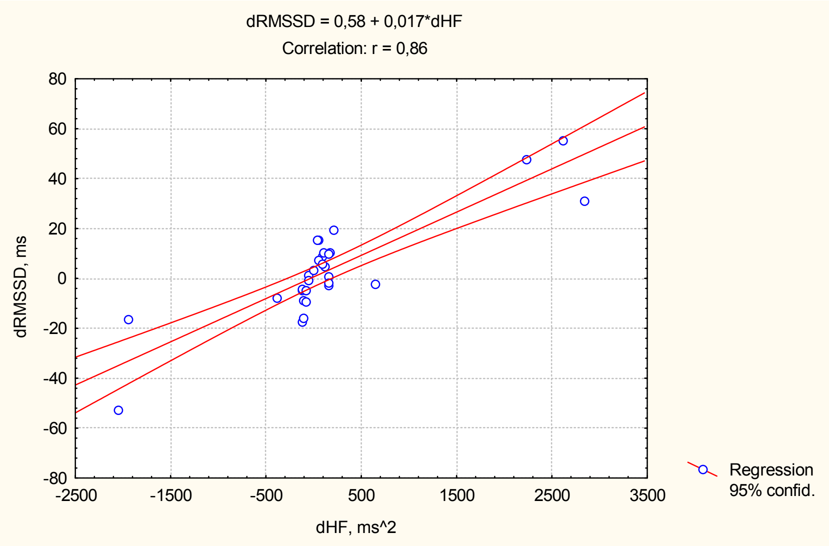

Figure 2. Correlation between changes for HF (axis of X) and RMSSD (axis of Y) parameters of HRV

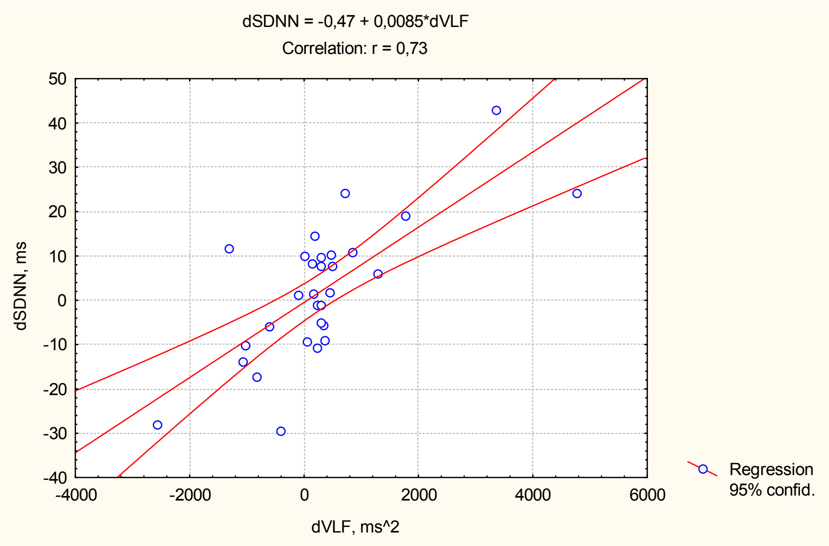

Figure 3. Correlation between changes for VLF (axis of X) and SDNN (axis of Y) parameters of HRV

UDC: 616.003.96-616.45-001.1/3-616-084

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Factor, canonical and discriminant analysis of vegetotropic effects and accompanying changes for thyroide, metabolic and haemodynamic parameters at the women, caused by bioactive water Naftussya

However, the relationship between changes in markers of sympathetic tone weaker (Figure 4).

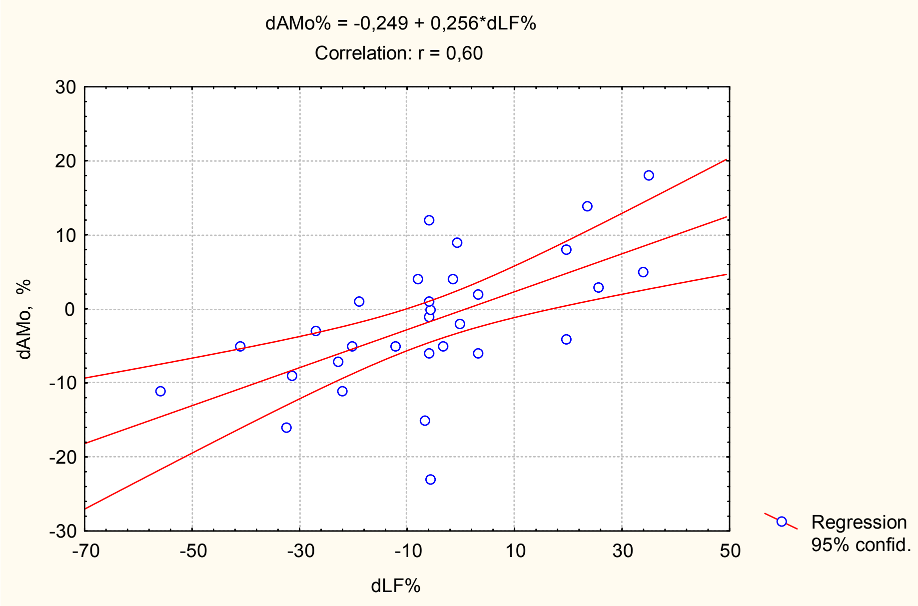
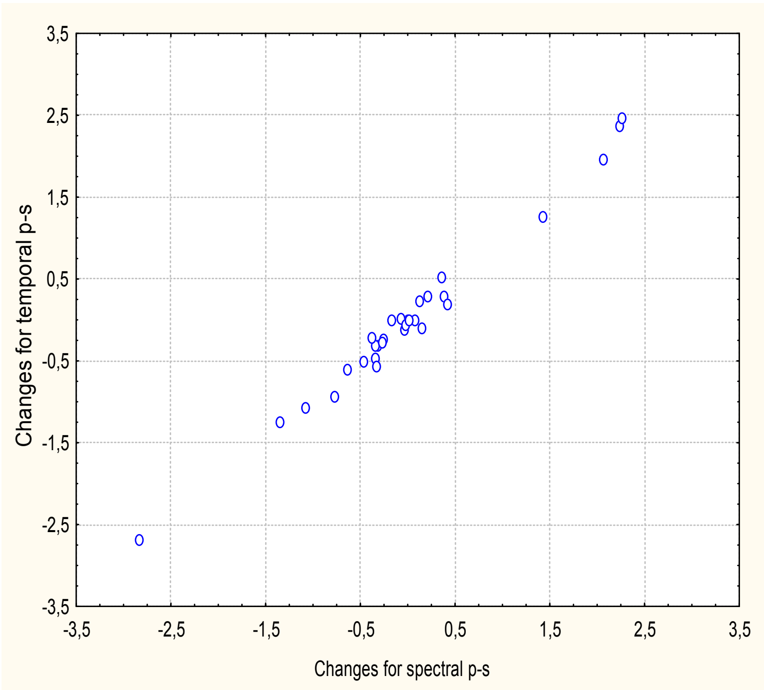


Figure 4. Correlation between changes for LF% (axis of X) and AMo (axis of Y) parameters of HRV

In general, relationships between changes for spectral, on the one hand, and temporal and Baevsky, on the other hand, parameters of HRV are very strong (Figure 5).



$R=0,99$; $R^2=0,98$; $\chi^2_{(70)}=194$; $p<10^{-6}$

Figure 5. Canonical correlation between changes for spectral (axis of X) and temporal and Baevsky (axis of Y) parameters of HRV

This factor structure of srectral canonical root is represented by changes of PSD of HFa (r=0,85), HFr (r=0,72), LFr (r=-0,58), VLFa (r=0,25), also LFnorm (r=-0,70) and LF/HF (r=-0,45). Another root is formed from changes in factor loadings pNN_{50} (r=0,91), RMSSD (r=0,89), AMo (r=-0,81), SDNN (r=0,76), HRV TI (r=0,71), ΔX (r=0,62) and Mo (r=0,35).

In order to identify the parameters which change specific to each of the three vegetotropic effects, was conducted discriminant analysis (method forward stepwise [30]). The program is included in model 9 discriminant variables (Tables 8 and 9).

The discriminant information is condensed in two canonical roots. The major root, as evidenced by the structural coefficients for canonical variables (correlations variables - canonical roots), straight representes changes for sympathetic markers, but by inversely modus representes markers of vagal tone. The minor root by inversely modus representes changes for relative PSD of VLF component HRV.

Table 8. Discriminant Function Analysis Summary
Step 9, N of variables in model: 9; Grouping: Vegetotropic effects (Vagotonic, Neutral, Sympathotonic)
Wilks' Lambda: 0,057; approx. $F_{(18)}$=6,70; $p<10^{-6}$

Discriminant variables changes	Wilks' Lambda	Partial Lambda	F-remove (2,19)	p-level	Tolerancy	1-Toler. (R^2)
d AMo/ΔX, units	0,092	0,627	5,65	0,012	0,266	0,734
d HF, %	0,066	0,874	1,37	0,283	0,030	0,970
d pNN_{50}, %	0,093	0,614	5,96	0,010	0,031	0,969
d TP, ms^2	0,091	0,631	5,56	0,012	0,027	0,972
d LF/HF	0,066	0,876	1,34	0,284	0,249	0,751
d VLF, ms^2	0,108	0,532	8,36	0,002	0,015	0,985
d VLF, %	0,079	0,725	3,61	0,047	0,100	0,900
d HF, ms^2	0,075	0,762	2,97	0,075	0,024	0,976
d 1/Mo•ΔX, units	0,067	0,861	1,54	0,241	0,339	0,660

Table 9. Results of discriminant analysis of changes of parameters specific to different vegetotropic effects of bioactive water Naftussya

Changes (d) for discriminant variables currently in the model	Parameters of Wilks' statistics			Coefficients for canonical variables				Coefficients for classification functions of effects		
	Λ	F	p<	**Raw** Root **1**	**Raw** Root **2**	**Structural** Root **1**	**Structural** Root **2**	**Vago-tonic n=10**	**Neutral n=9**	**Sympa-thotonic n=11**
d AMo/ΔX, units	0,255	39,4	10^{-6}	0,026	-0,019	**0,73**	0,01	-0,099	0,022	0,037
d 1/Mo•ΔX, units	0,057	6,70	10^{-6}	0,016	0,714	**0,55**	0,08	1,261	-0,627	1,328
d LF/HF	0,129	8,21	10^{-6}	0,125	0,216	**0,21**	0,06	-0,059	-0,302	0,599
d pNN_{50}, %	0,168	12,0	10^{-6}	0,106	-0,232	**-0,29**	0,01	-0,601	0,317	-0,032
d HF, ms^2	0,067	7,18	10^{-6}	-0,0001	0,005	**-0,29**	0,09	0,010	-0,004	0,009
d TP, ms^2	0,142	9,92	10^{-6}	-0,0012	-0,0026	**-0,25**	-0,07	-0,002	0,002	-0,008
d HF, %	0,207	15,6	10^{-6}	-0,068	0,109	**-0,23**	0,14	0,255	-0,227	-0,111
d VLF, ms^2	0,099	7,97	10^{-6}	0,0015	0,005	-0,09	-0,07	0,005	-0,005	0,013
d VLF, %	0,083	7,41	10^{-6}	-0,030	-0,102	-0,03	**-0,24**	-0,073	0,119	-0,233
	Constant			**-0,063**	**-0,622**	**Constant**		**-6,03**	**-2,23**	**-5,63**
Chi-square tests with successive roots removed	r_1^*=0,92; Wilks' Λ=0,06; $\chi^2_{(18)}$=66; $p<10^{-6}$				Means of canonical variables		**Root 1** 76%	**-2,77 ±0,37**	**-0,03 ±0,28**	**+2,54 ±0,29**
	r_2^*=0,79; Wilks' Λ=0,37; $\chi^2_{(8)}$=23; p=0,004						**Root 2** 24%	**+0,82 ±0,37**	**-1,88 ±0,28**	**+0,79 ±0,29**

The calculation of values of individual unstandardized canonical scores of roots by summation the multiplications of individual variables on the raw coefficients for canonical variables plus constants (see Table 9) allows vizualisation all the women on the plane of the two roots (Figure 6).

It is seen that women, liable to vagotonic vegetotropic effect (V), localized in the negative zone (centroide:-2,77) axis of root 1. This reflects (Table 10) reduction in these values of sympathetic markers (AMo/ΔX, 1/Mo•ΔX, LF/HF) and increasing quantities of parasympathetic markers (pNN_{50}, TP, HFa, HFr). Instead sympathotonic vegetotropic effect (S) illustrated the placement of women in the positive zone (centroide:+2,54) axis of major root. Neutral vegetotropic effect (N) corresponds to the placement of women around zero (centroide:-0,03). However, along the axis of root 2 vegetotropic effects of alternative habitats overlap, whereas neutral vegetotropic effect is illustrated lowest placing women, reflecting an increase of relative PSD of VLF component.

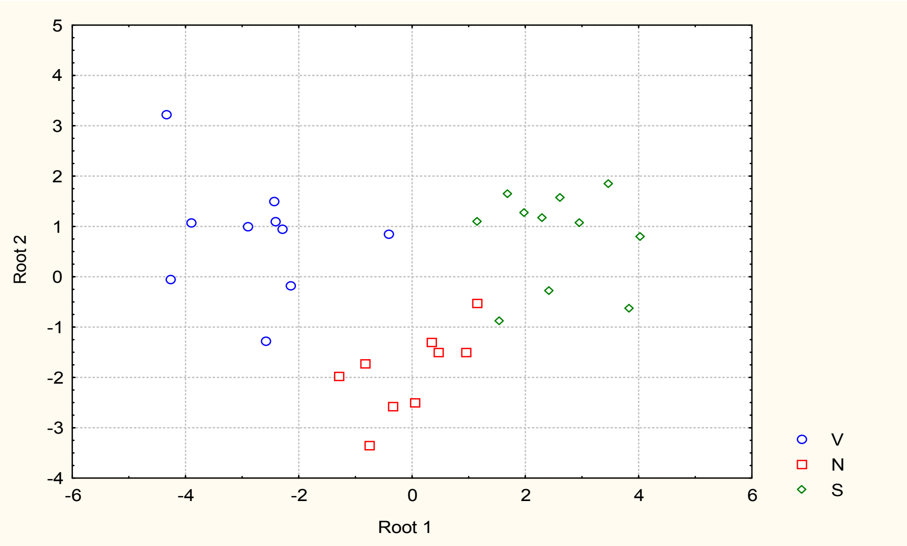


Figure 6. Unstandardized canonical scores of roots of changes for HRV parameters characterized various vegetotropic effects of bioactive water Naftussya

Table 10. Changes for parameters characterized various vegetotropic effects of BAWN

Changes (d) for discriminant variables	Vagotonic (10)	Neutral (9)	Sympathotonic (11)
d AMo/ΔX, units	-86 15#	-5 7	+76 15#
d 1/Mo•ΔX, units	-1,4 0,5#	+0,1 0,1	+1,9 0,3#
d LF/HF	-3,1 1,4#	-1,2 1,3	+1,7 0,6#
d pNN_{50}, %	+17,7 7,4#	+3,6 2,1	-8,8 4,8
d HF, ms^2	+1080 396#	+20 43	-535 252#
d TP, ms^2	+1531 502#	+471 268	-1065 661
d HF, %	+21 9#	-2 3	-9 6
d VLF, ms^2	+600 419	+539 184#	-274 608
d VLF, %	-2 7	+15 6#	-3 7

In general, all three clusters are clearly mutually separated. Squared Mahalanobis distances (D^2_M) between clusters V and N average 16,5 (F=5,5; $p<10^{-3}$), V and S: 31,3 (F=11,6; $p<10^{-5}$), N and S: 15,3 (F=5,3; p=0,001).

The analysis accompanying changes of thyroid hormones (Table 11) revealed a significant increase in plasma level triiod-thyronine by 40% at sympathotonic vegetotropic effect only.

Table 11. Levels of thyroide hormones before and after drinking BAWN and their direct differences

Variables	Effects	Vagotonic (10)			Neutral (9)			Sympathotonic (11)		
	Param	Before	After	Δ	Before	After	Δ	Before	After	Δ
Thyrotropic hormone, mIU/l	X ±m	4,53 0,87	3,59 0,80	-0,94 0,62	5,71 0,89	5,92 0,87	+0,22 0,68	5,79 1,11	5,62 1,33	-0,17 0,61
Thyroxine, nM/l	X ±m	101 14	104 11	+3 10	91 15	93 14	+2 12	88 10	102 14	+14 9
Triiod-thyronine, nM/l	X ±m	1,87 0,40	1,93 0,32	+0,06 0,32	1,72 0,37	1,79 0,35	+0,07 0,18	1,42 0,30	2,00 0,38	+0,58 0,21#

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Changes of thyroid hormone significantly positively correlated with changes in LF/HF ratio (Figure 7) and LFnorm (r=0,57) and negatively - with changes for HFr (r=-0,53) and HFa (r=-0,53). However, the dynamics of thyroxine correlated dynamics parameters of HRV is weaker, which is consistent with an increase in its plasma level in sympathotonic vegetotropic effect by 16% only. It should be noted also critical for power correlation between changes of thyrotropic hormone and HRV TI (r=-0,31).

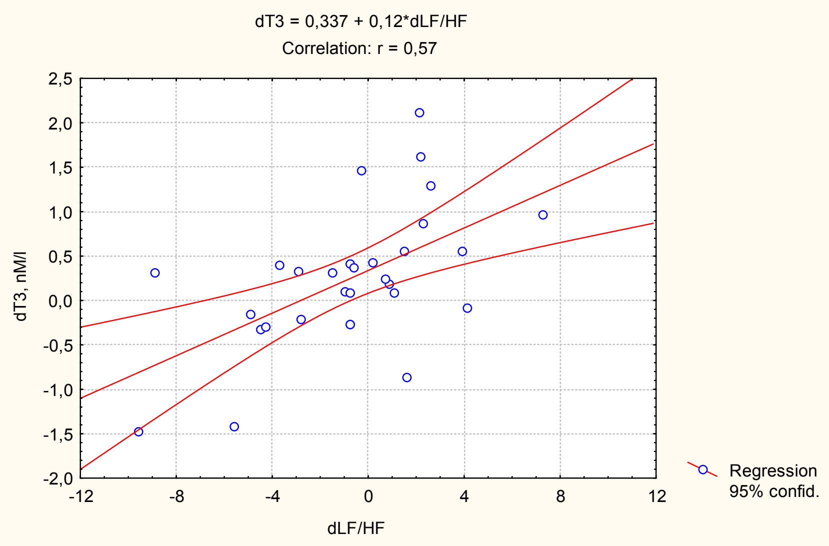
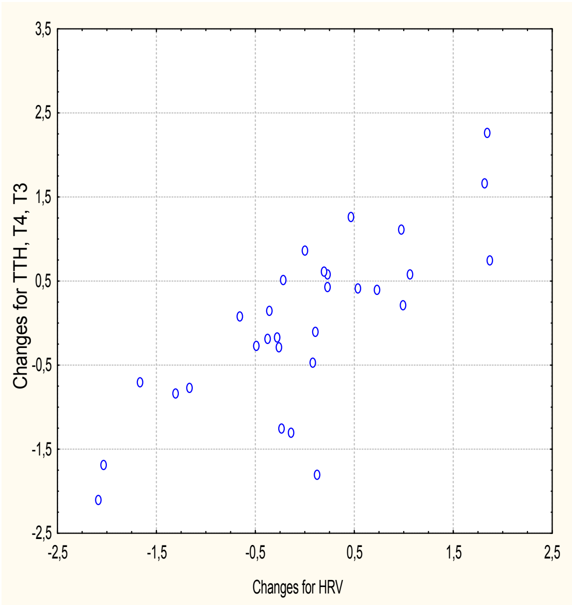


Figure 7. Correlation between changes for LF/HF ratio of HRV (axis of X) and for plasma level triiod-thyronine (axis of Y)

In general, relationships between changes for parameters of HRV, on the one hand, and changes for parameters of thyroide status, on the other hand, are strong (Figure 8).

Factor structure of vegetative canonical root is represented by changes of sympathetic markers LF/HF (r=0,66), LFnorm (r=0,48), LFr (r=0,45), LFa (r=0,35) and vagale markers RMSSD (r=-0,31), pNN_{50} (r=-0,29). Thyroide root is formed from changes in factor loadings of plasma levels T_4 (r=0,96), T_3 (r=0,83) and TTH (r=-0,29).



R=0,78; R^2=0,60; $\chi^2_{(36)}$=47; p=0,09

Figure 8. Canonical correlation between changes for parameters of HRV (axis of X) and thyroide status (axis of Y)

Parameters of lipid metabolism , as measured by the averages, naturally do not change for various vegetotropic effects (Table 12). However, the correlation analysis revealed a significant positive correlation between changes for LF/HF ratio of HRV and plasma level cholesterol of α-lipoproteines (Figure 9). Note the tendency to increase the plasma level uric acid in the vagotonic effect, no change in the neutral effect and the downward trend in uricaemia sympathotonic vegetotropic effect.

Table 12. Values of lipides and uric acid before and after drinking BAWN and their direct differences

Variables	Effects	Vagotonic (10)			Neutral (9)			Sympathotonic (11)		
	Params	Before	After	Δ	Before	After	Δ	Before	After	Δ
HDL cholesterol,	X	1,40	1,40	0,00	1,20	1,19	-0,02	1,21	1,29	+0,08
mM/l	±m	0,11	0,08	0,07	0,11	0,09	0,07	0,12	0,15	0,07
LDL cholesterol,	X	3,09	2,80	-0,29	2,78	2,33	-0,46	2,85	2,61	-0,24
mM/l	±m	0,35	0,29	0,15	0,26	0,27	0,27	0,29	0,33	0,19
VLDL cholesterol,	X	0,46	0,50	+0,04	0,72	0,76	+0,04	0,75	0,82	+0,07
mM/l	±m	0,04	0,05	0,06	0,16	0,12	0,09	0,14	0,18	0,11
Notα-Lipoproteines,	X	47,5	51,3	+3,8	56,0	52,9	-3,1	58,1	61,7	+3,6
units	±m	5,6	6,9	3,3	6,1	7,5	5,9	5,0	5,8	4,0
Uric acid,	X	232	259	+27	318	326	+8	329	303	-26
μM/l	±m	19	16	25	26	19	21	23	25	19

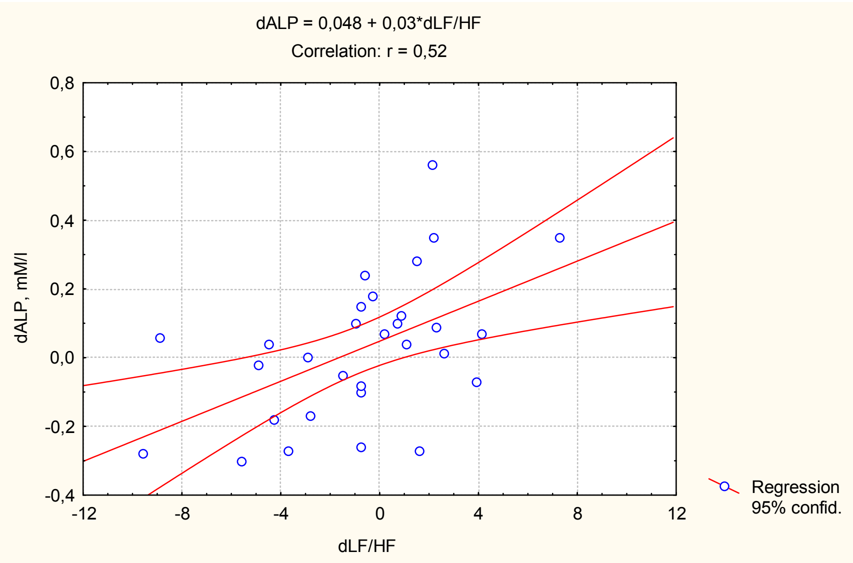


Figure 9. Correlation between changes for LF/HF ratio of HRV (axis of X) and for plasma level cholesterol of α-lipoproteines (axis of Y)

Analysis of changes related values of cationdepended ATPases activity showed a notsignificant decrease of 27 % activity of Ca-ATPase in sympathotonic vegetotropic effect only (Table 13), which is moderately correlated with changes HFa (r=-0,41).

Table 13. Values of cationdepended ATPases activity before and after drinking BAWN and their direct differences

Variables	Effects	Vagotonic (10)			Neutral (9)			Sympathotonic (11)		
	Param	Before	After	Δ	Before	After	Δ	Before	After	Δ
Na,K-ATPase,	X	1,08	1,14	+0,06	0,97	0,84	-0,14	0,90	0,90	0,00
M_{Ph}/l•h	±m	0,11	0,07	0,10	0,08	0,11	0,14	0,09	0,06	0,08
Ca-ATPase,	X	0,99	1,01	+0,02	1,03	1,15	+0,12	1,22	0,90	-0,33
M_{Ph}/l•h	±m	0,17	0,15	0,17	0,16	0,12	0,16	0,12	0,09	0,19
Mg-ATPase,	X	0,87	0,86	-0,01	0,98	0,99	+0,01	1,03	0,90	-0,13
M_{Ph}/l•h	±m	0,06	0,05	0,08	0,05	0,05	0,06	0,10	0,03	0,09

The additional slight influence on activity of Ca-ATPase causes moda (Figure 10).

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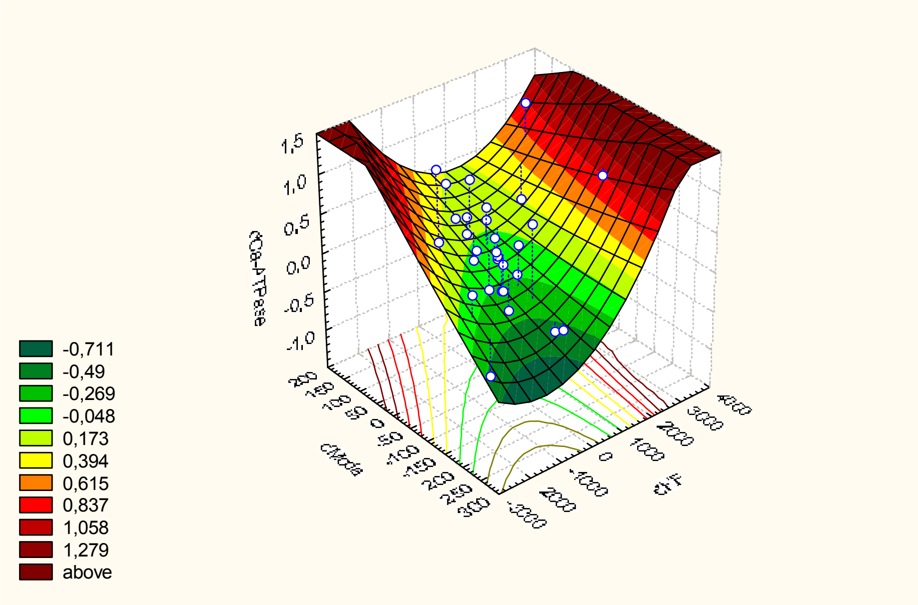


dCa-ATPase (M/l•h) = 0,0002•dHF (ms^2) + 0,0012•dMo (ms) – 0,068
R=0,45; R^2=0,20; $F_{(2,3)}$=3,5; p=0,043

Figure 10. Correlations between changes for HF (axis of X), moda (axis of Y) and activity of Ca-ATPase (axis of Z)

Analysis of changes related parameters of exchange of electrolytes (Table 14) showed a tendency to decrease plasma level chloride and sodium in vagotonic effect, no change in the neutral effect and tends to increase these major electrolytes of plasma in sympathotonic vegetotropic effect. Correlation analysis shows a significant correlation between the dynamics chloridaemia and AMo (Figure 11) and a moderate relationship between the dynamics of Na^+ and HFa (r=-0,41). Despite the fuzzy dynamics Mg^{2+}, stated her moderate negative correlation with the dynamics LFr (Figure 12). Even more surprising, given the means, is moderate negative correlation between the dynamics erhytrocytes level potassiun and VLFa (r=-0,47).

Table 14. Levels of electrolytes before and after drinking BAWN and their direct differences

Variables	Effects	Vagotonic (10)			Neutral (9)			Sympathotonic (11)		
	Param	**Before**	**After**	**Δ**	**Before**	**After**	**Δ**	**Before**	**After**	**Δ**
Plasma Chloride, mM/l	X ±m	102,5 3,0	98,9 2,4	-3,6 4,1	99,1 3,2	99,2 2,3	0,0 4,2	95,1 2,3	100,1 1,6	+5,0 2,6
Plasma Sodium, mM/l	X ±m	146 6	144 6	-2 7	134 5	136 3	+2 6	139 9	147 5	+8 10
Plasma Phosphates, mM/l	X ±m	1,00 0,07	0,84 0,06	-0,15 0,10	0,91 0,12	0,84 0,07	-0,07 0,09	0,92 0,10	0,94 0,06	+0,03 0,09
Plasma Calcium, mM/l	X ±m	2,39 0,11	2,34 0,11	-0,05 0,10	2,17 0,10	2,07 0,07	-0,10 0,14	2,19 0,09	2,31 0,07	+0,12 0,10
Plasma Magnesium, mM/l	X ±m	0,80 0,03	0,79 0,03	-0,01 0,03	0,76 0,02	0,74 0,02	-0,02 0,02	0,77 0,02	0,72 0,03	-0,05 0,03
Plasma Potassium, mM/l	X ±m	4,37 0,22	4,09 0,23	-0,28 0,32	4,02 0,29	4,22 0,18	+0,20 0,38	4,34 0,24	4,46 0,11	+0,12 0,28
Erhytrocytes Sodium, mM/l	X ±m	25,7 1,4	27,7 3,1	+2,0 3,9	26,1 1,9	23,5 1,2	-2,6 2,9	24,5 1,5	26,6 1,9	+2,1 2,7
Erhytrocytes Potassium, mM/l	X ±m	77,5 5,5	66,2 4,2	-11,3 5,9	70,6 3,8	72,4 3,5	+1,8 4,6	77,5 5,7	77,1 6,0	-0,4 6,2

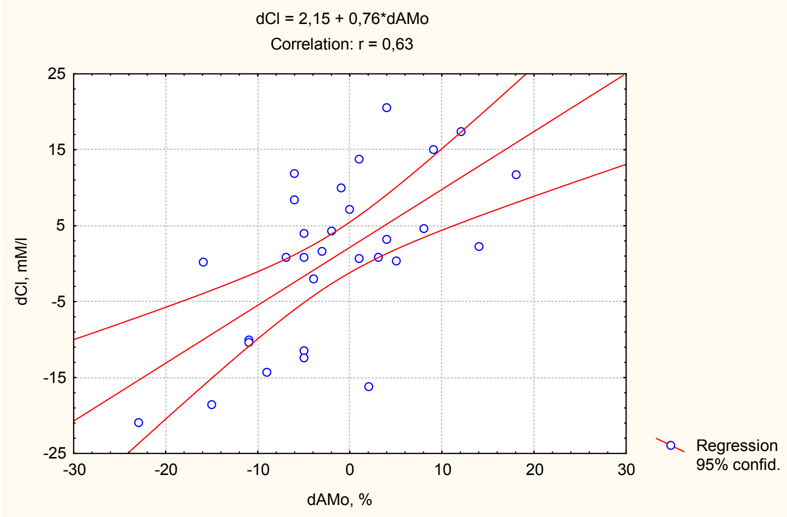


Figure 11. Correlation between changes for AMo (axis of X) and for plasma level chloride (axis of Y)

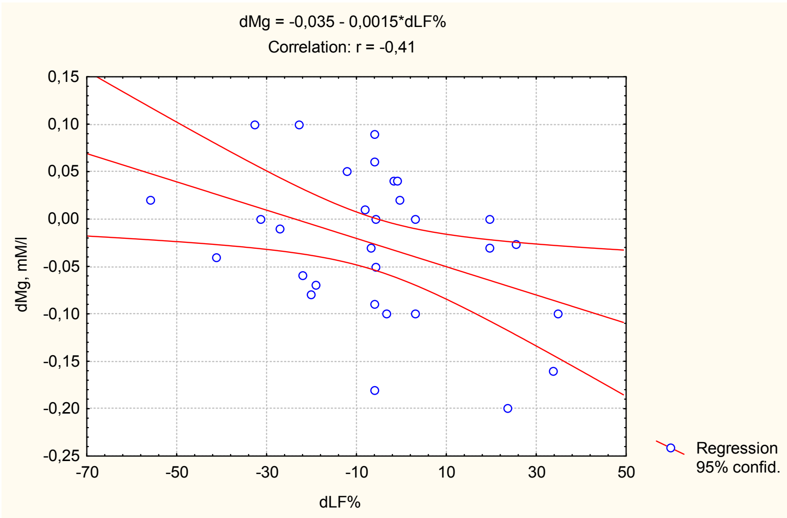
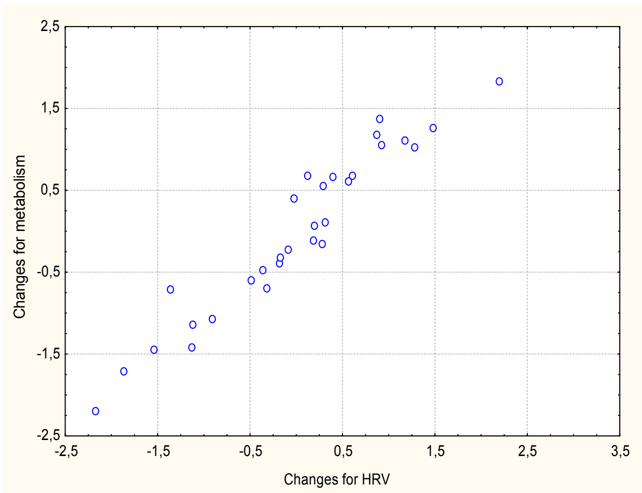


Figure 12. Correlation between changes for LF% (axis of X) and for plasma level magnesium (axis of Y)

In general, relationships between changes for parameters of HRV, on the one hand, and changes for metabolic parameters, on the other hand, are strong (Figure 13).



$R=0{,}96$; $R^2=0{,}92$; $\chi^2_{(121)}=150$; $p=0{,}036$

Figure 13. Canonical correlation between changes for parameters of HRV (axis of X) and for metabolic parameters (axis of Y)

Factor structure of vegetative canonical root is represented by changes of AMo (r=0,77), SDNN (r=-0,49), LFr (r=0,49), VLFa (r=-0,46), HRV TI (r=-0,42), pNN_{50} (r=-0,37) and RMSSD (r=-0,33). Metabolic root is formed from changes in factor loadings of plasma levels Cl^-(r=0,63), phosphates (r=0,50), Ca^{2+} (r=0,28), Na^+ (r=0,20), HDL cholesterol (r=0,11), erhytrocytes level K^+ (r=0,60) and Mg-ATPase activity (r=-0,32) (?).

For integrated assessment of hemodynamic effects BAWN (Table 15) used **index** of myocardial **contractile** activity (CI) by Popovych IL [4,24], calculated by the formula: CI=0,1332•BPm•SV/EDV•ET.

Table 15. Parameters of haemodynamic before and after drinking BAWN and their direct differences

Variables	Effects	Vagotonic (10)			Neutral (9)			Sympathotonic (11)		
	Params	Before	After	Δ	Before	After	Δ	Before	After	Δ
Contractility index of left ventricul (CI), kPa/s	X	27,7	20,8	-6,8	26,0	26,1	+0,1	20,2	26,5	+6,3
	±m	1,3	1,3	$1,5^{\#}$	1,0	1,0	0,5	1,0	1,7	$1,1^{\#}$
Enddiastolic volume of left ventricul (EDV), ml	X	131	113	-18	128	128	0	113	123	+10
	±m	5	5	$3^{\#}$	3	4	3	6	8	$5^{\#}$
Endsystolic volume of left ventricul (ESV), ml	X	52	56	+4	51	52	+1	57	54	-3
	±m	5	4	3	4	4	2	4	4	2
Shock volume of left ventricul (SV), ml	X	79	57	-22	77	76	-1	56	69	+13
	±m	4	6	$5^{\#}$	5	4	3	5	6	$6^{\#}$
Ejection time (ET), ms	X	281	282	+1	282	285	+3	289	269	-20
	±m	9	10	8	12	12	8	9	12	11
Systolic blood pressure (BPs), mm Hg	X	126	118	-8	121	122	+1	118	122	+4
	±m	6	4	6	5	3	4	3	2	2
Diastolic blood pressure (BPd), mm Hg	X	82	75	-7	77	81	+4	77	82	+5
	±m	3	3	4	2	3	3	2	2	$2^{\#}$
Mean blood pressure (BPm), mm Hg	X	96,2	89,2	-7,0	91,4	94,0	+2,6	90,4	94,7	+4,3
	±m	4,0	2,8	4,2	2,8	2,7	2,9	2,3	2,3	$1,5^{\#}$
Ejection fraction (EF), %	X	61	50	-11	60	59	-1	49	55	+6
	±m	3	4	$3^{\#}$	3	3	2	3	2	$3^{\#}$
Heart rate (HR), beats/min	X	69,0	68,8	-0,3	67,8	66,3	-1,5	67,4	72,7	+5,3
	±m	4,4	4,6	2,1	2,6	1,9	1,7	3,9	3,8	3,1
Cardiac output (CO), l/min	X	5,38	3,83	-1,56	5,24	5,03	-0,22	3,80	5,02	+1,22
	±m	0,27	0,38	$0,40^{\#}$	0,35	0,23	0,23	0,44	0,59	$0,43^{\#}$
General resistance of periferal vessels (GRPV), kPa•s/m^3	X	14,6	20,1	+5,5	14,4	15,3	+0,9	22,0	16,4	-5,5
	±m	0,9	1,7	$2,1^{\#}$	0,9	1,0	0,8	2,8	1,3	$2,1^{\#}$
Type of circulation, points	X	-0,5	-2,4	-1,9	-0,7	-0,8	-0,1	-2,8	-1,0	+1,8
	±m	0,5	0,6	$0,8^{\#}$	0,7	0,5	0,4	0,7	0,6	$0,6^{\#}$

We found that the vagotonic effect accompanied by a decrease of CI and sympathotonic effect - increasing IC, in the absence of changes in the neutral vegetotropic effect. The negative inotropic effect BAWN shown a decrease in SV greater extent (-28±6 %) than EDV (-14±2%), and a downward trend BPm (-7,2±4,3%) in the absence of regular changes of ET. However, increasing CI achieved by the prevalence rates of SV (+22±11%) of the increase EDV (+9±4%), and increased BPm (+4,7±1,7%) and a downward trend ET (-7,1±3,9%).

Overall vagotonic effect accompanied by a transition from eukinetic (0÷-1 points) type of circulation to hypokinetic (-2÷-3 points) type. However, when sympathotonic effect of BAWN the hypokinetic type is transformed into eukinetic type of circulation.

Correlation analysis showed the expected strong positive relationship between changes in markers of sympathetic tone both EDV (Figure 14), SV (Figure 15) and cardiac output (r=0,79). Instead relationship between changes AMo and ESV was moderate and negative (r=-0,37).

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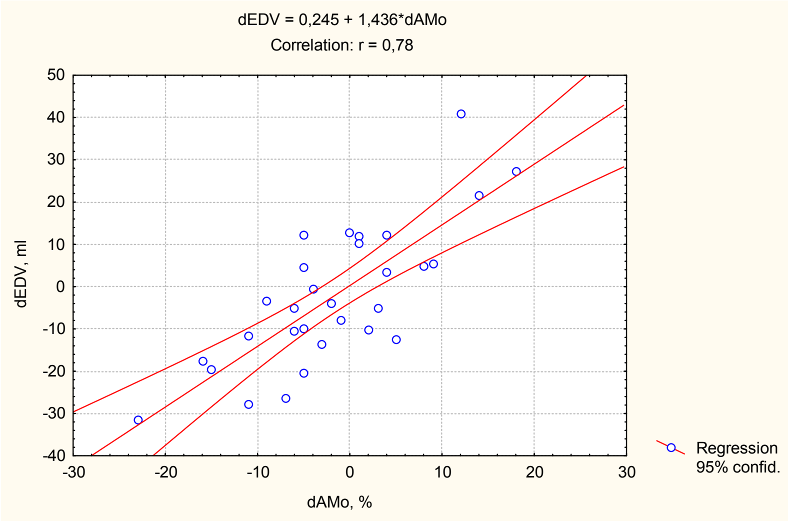

Figure 14. Correlation between changes for AMo (axis of X) and for enddiastolic volume of left ventricul (axis of Y)

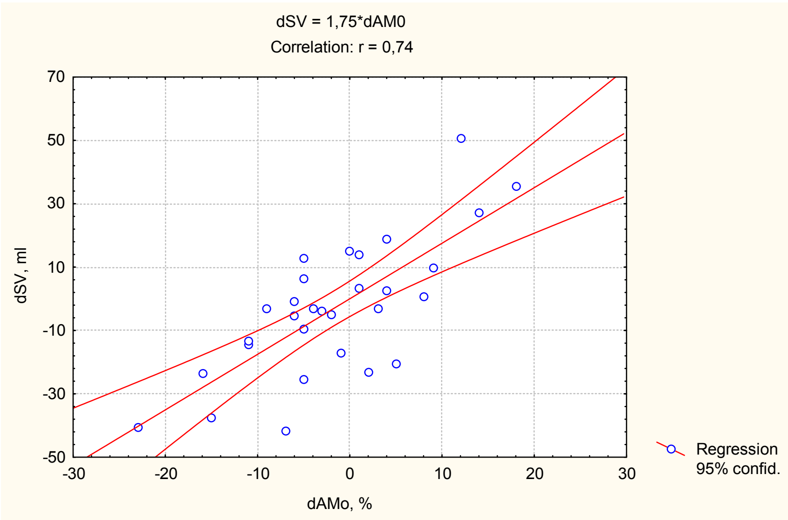

Figure 15. Correlation between changes for AMo (axis of X) and for shock volume of left ventricul (axis of Y)

Dynamics of arterial blood pressure negatively associated with changes of vagale markers, while the more sensitive was diastolic blood pressure (Figure 16) than systolic blood pressure (Figure 17).

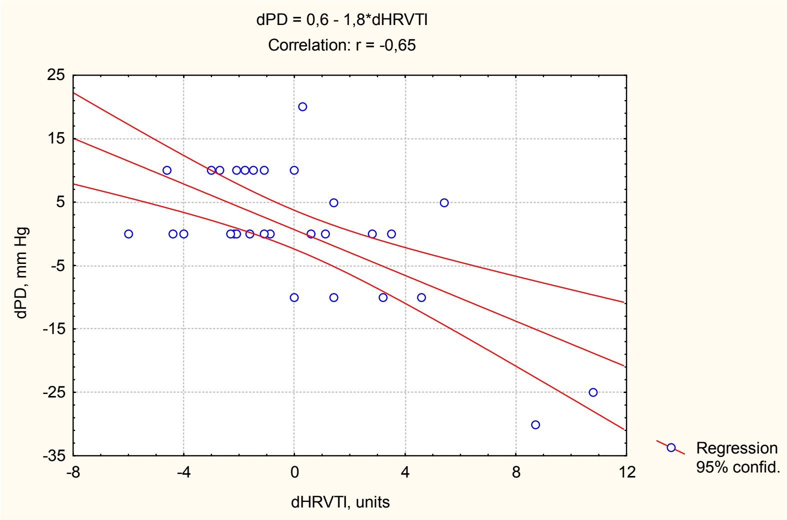

Figure 16. Correlation between changes for HRV TI (axis of X) and diastolic blood pressure (axis of Y)

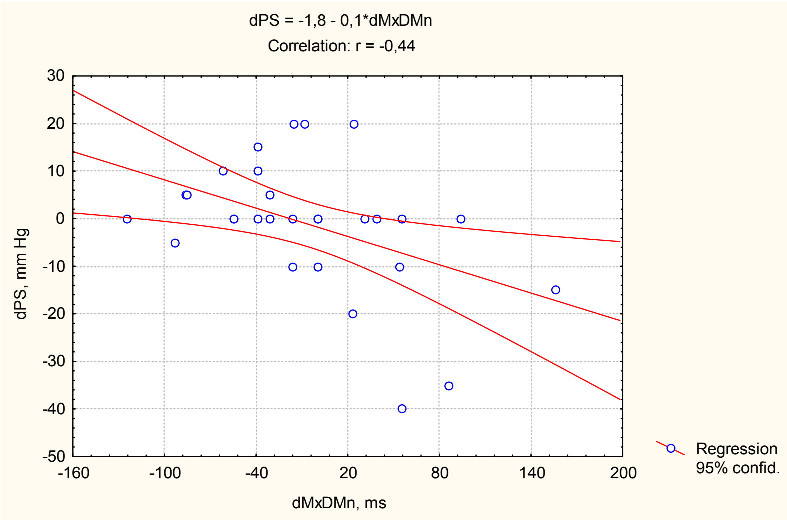

Figure 17. Correlation between changes for variative swing (axis of X) and for systolic blood pressure (axis of Y)

The ejection time responding to changes in autonomic regulation moderately only (Figure 18).

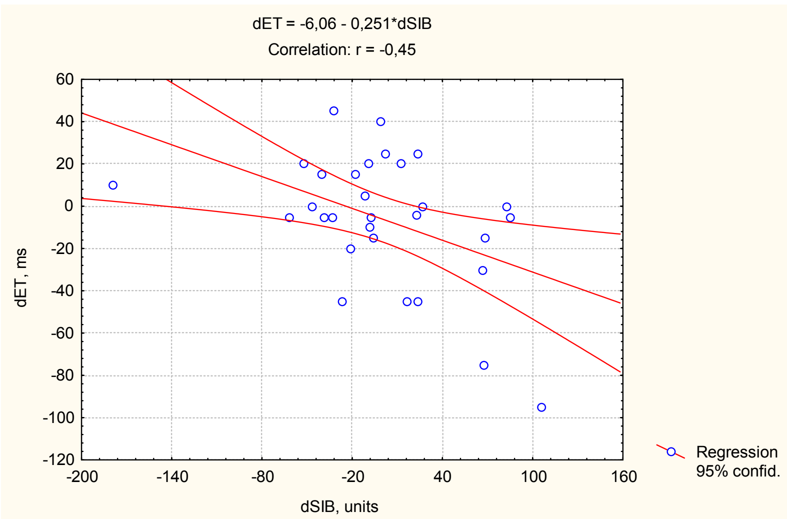

Figure 18. Correlation between changes for stress-index Baevsky (axis of X) and for ejection time of left ventricul (axis of Y)

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O.V. Kozyavkina, H.I. Vis'tak, I.L. Popovych

Factor, canonical and discriminant analysis of vegetotropic effects and accompanying changes for thyroide, metabolic and haemodynamic parameters at the women, caused by bioactive water Naftussya

As a result, calculated using these parameters CI is very sensitive to changes of sympathetic tone (Figure 19).

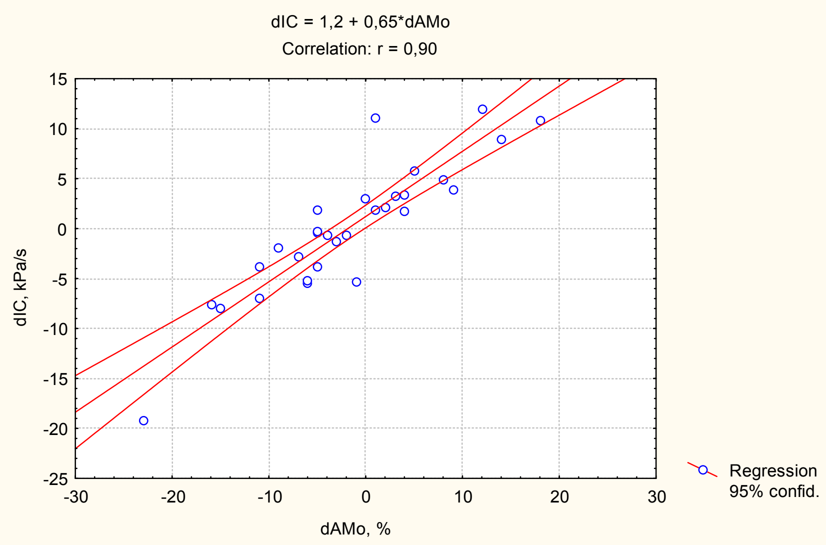
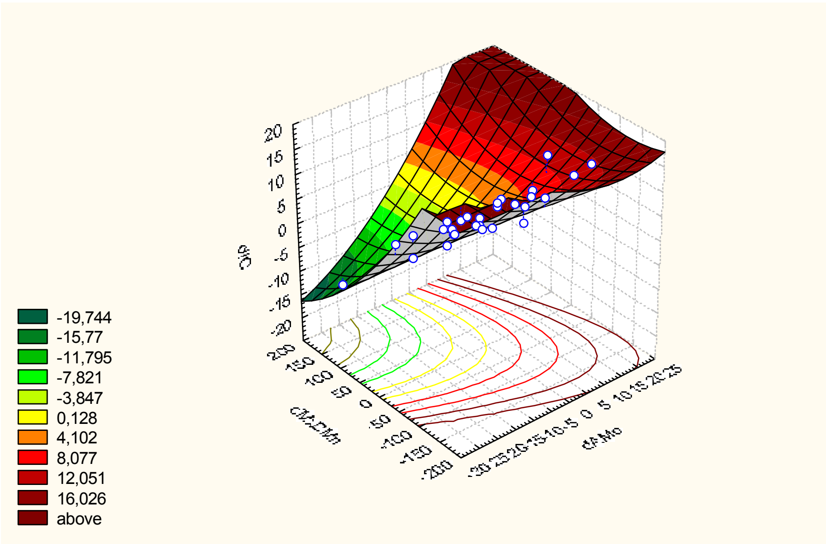


Figure 19. Correlation between changes for AMo (axis of X) and for contractility index of left ventricul (axis of Y)

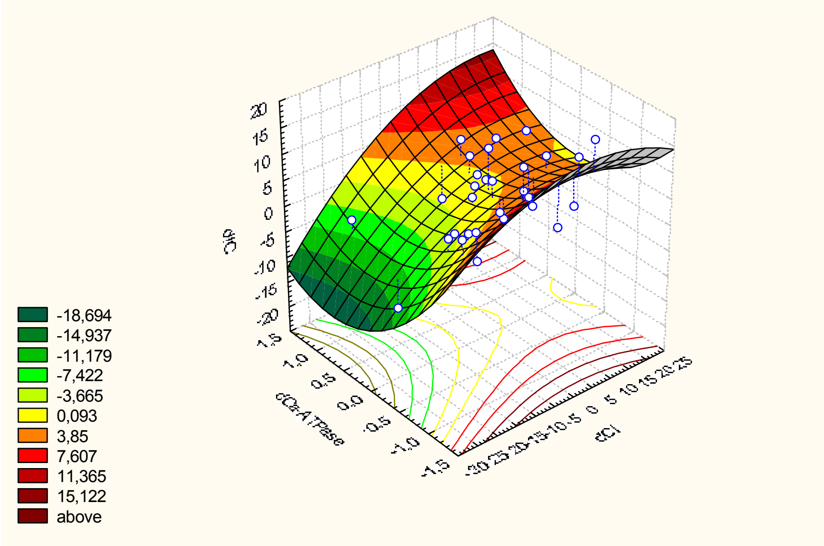
Proved to be even more dependent changes of CI reciprocal changes in sympathetic and parasympathetic regulatory factors (Figure 20).



dCI (kPa/s)= 0,345•dAMo (%) - 0,06•dMxDMn (ms) + 0,3
R=0,97; R^2=0,94; $F_{(2,3)}$=217; p<10^{-5}

Figure 20. Correlations between changes for AMo (axis of X), variative swing (axis of Y) and contractility index of left ventricul (axis of Z)

On the other hand showed a strong dependence of the dynamics of CI for change plasma level chloride and activity of erhytrocytes Ca-ATPase (Figure 21).



dCI (kPa/s)= 0,30•dCl (mM/l) - 3,97•dCa-ATPase (M/l•h) - 0,4
R=0,58; R^2=0,34; $F_{(2,3)}$=6,9; p=0,004

Figure 21. Correlations between changes for plasma level chloride (axis of X), activity of erhytrocytes Ca-ATPase (axis of Y) and contractility index of left ventricul (axis of Z)

The additional including in equation of multiple regression erhytrocytes level potassium increases dependence of the dynamics of CI for changes same metabolic factors:

dCI (kPa/s)= 0,32•dCl (mM/l) - 4,43•dCa-ATPase (M/l•h) + 0,123•dKer - 0,05
R=0,67; R^2=0,45; $F_{(3,3)}$=7,1; p=0,001

Among parameters of submaximal veloergometric test significantly changed detected by vagotonic effect BAWN only (Table 16). In response to physical load 1,5 W/kg neither heart rate, no PWC_{150} changed, but decreased response of arterial blood pressure: systolic on 8%, dyastolic on 7%, mean on 7,5%. As a result tachycardic hypertensive reaction index (THRI) by Popovych I.L. [4,24], calculated by the formula: THRI = 1,5•10^6/HR•BPs, increased on 8,5%.

Table 16. Parameters of submaximal veloergometric test beforee and after drinking BAWN and their direct differences

Variables	Effects	Vagotonic (10)			Neutral (9)			Sympathotonic (11)		
	Params	Before	After	Δ	Before	After	Δ	Before	After	Δ
Systolic blood pressure	X	149	137	-12	140	138	-2	143	139	-4
(BPs), mm Hg	±m	7	5	$5^{\#}$	3	2	2	6	6	4
Diastolic blood pressure	X	87	81	-6	83	81	-2	80	83	+3
(BPd), mm Hg	±m	3	3	$2^{\#}$	3	3	2	3	3	3
Mean blood pressure	X	107	99	-8	102	100	-2	101	102	+1
(BPm), mm Hg	±m	4	3	$3^{\#}$	3	3	2	4	4	3
Heart rate	X	130	130	0	133	140	+6	134	137	+3
(HR), beats/min	±m	6	6	3	4	5	6	4	3	3
Physical working capacity	X	2,38	2,32	-0,06	1,93	1,79	-0,14	2,22	1,87	-0,35
(PWC_{150}), W/kg	±m	0,33	0,23	0,28	0,12	0,10	0,15	0,31	0,13	0,24
Tachycardic hypertensive rea-	X	78,0	84,6	+6,7	79,0	78,6	-0,4	77,3	77,7	+0,4
ction index, μW/kg•beat•mm	±m	5,4	7,1	$2,9^{\#}$	3,9	2,3	3,2	5,9	5,1	2,4

It is detected moderate negative dependence between changes for HFa and diastolic blood pressure during submaximal veloergometric test (Figure 22).

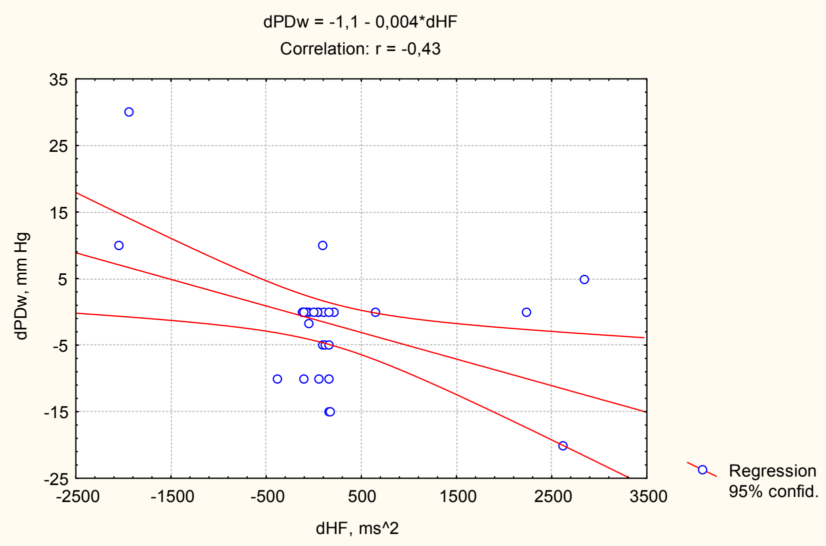
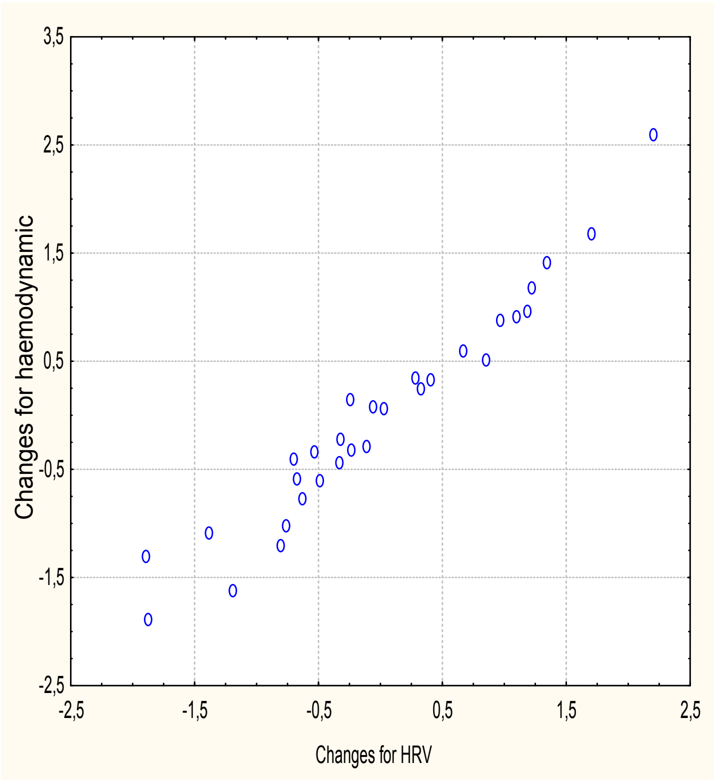


Figure 22. Correlation between changes for HF (axis of X) and for diastolic blood pressure during submaximal veloergometric test (axis of Y)

In general, relationships between changes for parameters of HRV, on the one hand, and changes for haemodynamic parameters, on the other hand, are very strong (Figure 23).



$R=0{,}97$; $R^2=0{,}95$; $\chi^2_{(54)}=127$; $p<10^{-6}$

Figure 23. Canonical correlation between changes for parameters of HRV (axis of X) and haemodynamic (axis of Y)

Factor structure of vegetative canonical root is represented by changes of variative swing (r=0,94), AMo (r=-0,86), HRV TI (r=0,81), Total power HRV (r=0,53), VLFa (r=-0,46) and pNN_{50} (r=0,51). Haemodynamic root is formed from changes in factor loadings of EDV (r=-0,88), CO (r=-0,79), diastolic BP (r=-0,64), systolic BP (r=-0,40), ESV (r=0,37) and diastolic BP during submaximal veloergometric test (r=-0,31).

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In order to identify the parameters which change specific to each of the three vegetotropic effects, was conducted discriminant analysis again. The program is included in model 10 discriminant variables (Tables 17 and 18).

Table 17. Discriminant Function Analysis Summary
Step 10, N of variables in model: 10; Grouping: Vegetotropic effects (Vagotonic, Neutral, Sympathotonic)
Wilks' Lambda: 0,051; approx. $F_{(20)}$=6,17; p<10^{-6}

Changes for discriminant variables	**Wilks' Lambda**	**Partial Lambda**	**F-remove (2,18)**	**p-level**	**Tole-rancy**	**1-Toler. (R^2)**
Contractility index, kPa/s	0,377	0,135	57,5	0,000	0,287	0,713
Triiod-thyronine, nM/l	0,083	0,612	5,69	0,012	0,563	0,437
Working Syst. BP, mmHg	0,091	0,559	7,11	0,005	0,571	0,428
Plasma Uric acid, µM/l	0,067	0,757	2,88	0,082	0,651	0,348
Plasma Chloride, mM/l	0,067	0,765	2,77	0,089	0,472	0,527
Ca-ATPase, M_{Ph}/l•h	0,065	0,781	2,52	0,108	0,653	0,346
Na,K-ATPase, M_{Ph}/l•h	0,060	0,846	1,64	0,222	0,755	0,244
Notα-Lipoproteines, un.	0,069	0,742	3,13	0,068	0,390	0,609
Plasma Calcium, mM/l	0,062	0,822	1,95	0,171	0,294	0,705
Mg-ATPase, M_{Ph}/l•h	0,057	0,895	1,06	0,368	0,368	0,631

Table 18. Results of discriminant analysis of changes of notvegetative parameters specific to different vegetotropic effects of bioactive water Naftussya

Changes for discriminant Variables currently in the model	**Parameters of Wilks' statistics**			**Coefficients for canonical variables**				**Coefficients for classifica-tion functions of effects**		
				Raw		**Structural**				
	Λ	**F**	**p<**	Root **1**	Root **2**	Root **1**	Root **2**	**Vago-tonic n=10**	**Neu-tral n=9**	**Sympa-thotonic n=11**
Contractility index, kPa/s	0,281	34,5	10^{-6}	0,502	-0,008	**0,48**	0,18	-2,128	0,150	1,602
Plasma Chloride, mM/l	0,099	10,0	10^{-6}	-0,065	-0,031	**0,09**	0,09	0,250	0,003	-0,241
Working Syst. BP, mmHg	0,153	13,0	10^{-6}	0,068	-0,036	**0,09**	-0,19	-0,346	0,020	0,157
Triiod-thyronine, nM/l	0,216	15,0	10^{-6}	1,064	0,526	**0,08**	0,22	-3,876	0,119	4,146
Plasma Uric acid, µM/l	0,127	10,8	10^{-6}	-0,009	-0,001	**-0,10**	-0,12	0,040	-0,001	-0,029
Mg-ATPase, M_{Ph}/l•h	0,051	6,2	10^{-6}	-2,134	1,357	**-0,06**	-0,22	9,093	-2,722	-6,589
Na,K-ATPase, M_{Ph}/l•h	0,075	8,0	10^{-6}	-0,842	1,845	-0,03	**0,30**	4,834	-1,892	-1,133
Notα-Lipoproteines, un.	0,066	7,3	10^{-6}	-0,030	0,081	-0,01	**0,29**	0,187	-0,076	-0,020
Plasma Calcium, mM/l	0,057	6,7	10^{-6}	-1,485	2,750	0,05	**0,23**	7,674	-3,394	-2,935
Ca-ATPase, M_{Ph}/l•h	0,088	8,7	10^{-6}	0,816	-1,190	-0,07	**-0,31**	-4,372	1,202	1,511
	Constant			**0,181**	**-0,420**	**Constant**		**-10,70**	**-1,637**	**-6,680**
Chi-square tests with successive roots removed	r_1^*=0,96; Wilks' Λ=0,05; $\chi^2_{(20)}$=67; p=10^{-6}				Means of canonical variables		**Root 1** 94%	**-4,09 ±0,31**	**+0,44 ±0,33**	**+3,36 ±0,31**
	r_2^*=0,63; Wilks' Λ=0,60; $\chi^2_{(9)}$=11; p=0,26						**Root 2** 6%	**+0,41 ±0,34**	**-1,16 ±0,38**	**+0,58 ±0,24**

The discriminant information is condensed in two canonical roots. The major root straight representes changes for contractility index, systolic blood pressure during veloergometric test, plasma levels of chloride, triiod-thyronine and uric acid, erhytrocytes activity of Mg-ATPase. The minor root by inversely modus representes changes for erhytrocytes activity of Na,K- and Ca-ATPases, plasma levels of notα-Lipoproteines and calcium.

The calculation of values of individual unstandardized canonical scores of roots (Tables 18 and 19) allows vizualisation all the women on the plane of the two roots (Figure 24).

It is seen that women, liable to vagotonic vegetotropic effect (V), localized in the negative zone (centroide:-4,09) axis of root 1. This reflects (Table 15) decreasing in these values of contractility index, chloridaemia and working systolic BP but increasing value of uric acid. Instead sympathotonic vegetotropic effect (S) illustrated the placement of women in the positive zone (centroide:+3,36) axis of major root. This reflects increasing values of CI, chloride and triiod-thyronine but decreasing value of uric acid and activity of Mg-ATPase. Neutral vegetotropic effect (N) accompanied notsignificantly changes for those parameters corresponds to the placement of women around zero (centroide:+0,44). However, along the axis of root 2 vegetotropic effects of alternative habitats overlap, whereas neutral vegetotropic effect is illustrated lowest placing (centroide:-1,16) women, reflecting an decrease of activity of Na,K-ATPases, notα-Lipoproteines and calciumaemia but increase of activity of Ca-ATPase.

Table 19. The changes for notvegetative parameters specific to different vegetotropic effects of bioactive water Naftussya

Changes for discriminant variables	Vagotonic (10)	Neutral (9)	Sympathotonic (11)
Contractility index, kPa/s	-6,8 1,5#	+0,1 0,5	+6,3 1,1#
Plasma Chloride, mM/l	-3,6 4,1	0,0 4,2	+5,0 2,6
Working Systolic BP, mmHg	-12 5#	-2 2	-4 4
Triiod-thyronine, nM/l	+0,06 0,32	+0,07 0,18	+0,58 0,21#
Plasma Uric acid, µM/l	+27 25	+8 21	-26 19
Mg-ATPase, M_{Ph}/l•h	-0,01 0,08	+0,01 0,06	-0,13 0,09
Na,K-ATPase, M_{Ph}/l•h	+0,06 0,10	-0,14 0,14	0,00 0,08
Notα-Lipoproteines, units	+3,8 3,3	-3,1 5,9	+3,6 4,0
Plasma Calcium, mM/l	-0,05 0,10	-0,10 0,14	+0,12 0,10
Ca-ATPase, M_{Ph}/l•h	+0,02 0,17	+0,12 0,16	-0,33 0,19

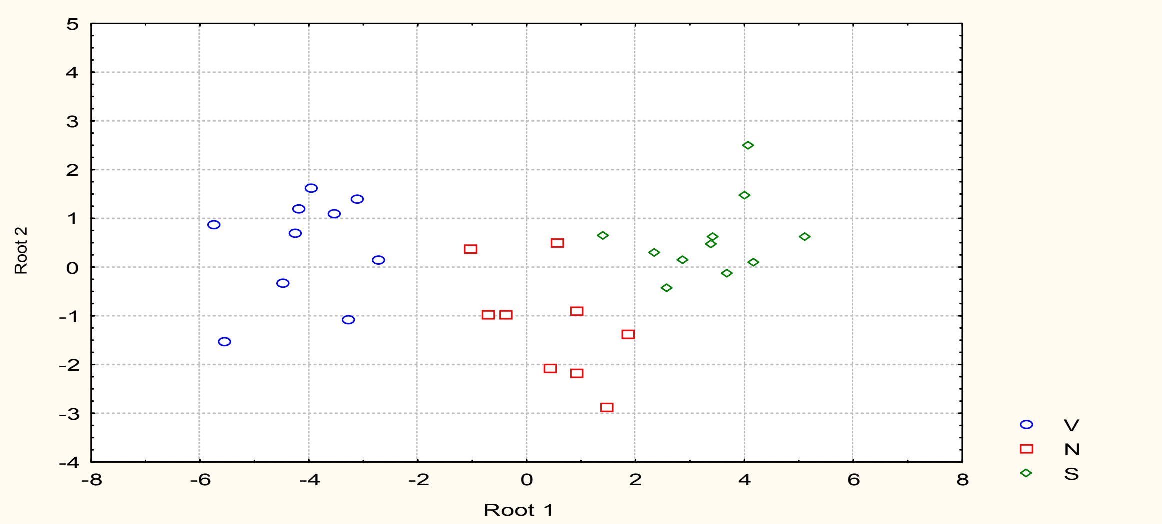

Figure 24. Unstandardized canonical scores of roots of changes for notvegetative parameters characterized various vegetotropic effects of bioactive water Naftussya

In general, all three clusters are clearly mutually separated. D^2_M between clusters V and N average 25,6 (F=7,2; $p<10^{-3}$), V and S: 61,8 (F=19,5; $p<10^{-6}$), N and S: 12,9 (F=3,8; p=0,007).

In order to clarify the possibility of predicting the nature vegetotropic effect of BAWN conducted discriminant analysis reported initial settings. Forward stepwise method identified 12 predictors (Table 20), knowledge of which condensed the two roots. Major root containing 78% predictive capabilities and represents directly contractility index, stress index Baevsky and systolic blood pressure and the reverse way uricemia, triangular index, erythrocytes Mg-ATPase and Ca-ATPase activity.

The values of those predictors are maximum/minimum in women subordinates vagotonic effect, while are minimum/maximum in women subordinates sympathotonic effect for intermediate values in the cases of neutral vegetotropic effect: patterns V>N>S or V<N<S (Figure 25). Minor canonical discriminant radical (the remaining 22% predictive capabilities) becomes positive factor load from SDNN, the height of women, plasma levels of potassium and phosphates and negative factor load from AMo. Fees predictors are minimal in women not subordinates vegetotropic effect, while not significantly different among women two other alternative groups: patterns V<N>S or V>N<S.

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Table 20. Results of discriminant analysis of parameters for forecasting of different vegetotropic effects of bioactive water Naftussya

Discriminant variables currently in the model	Parameters of Wilks' statistics			Coefficients for canonical variables				Means of predictors of different vegetotropic effects		
	Λ	F	p	Raw		Structural		Vagotonic n=10	Neutral n=9	Sympathot n=11
				Root 1	Root 2	Root 1	Root 2			
Contractility index, kPa/s	0,51	13	10^{-4}	1,63	0,24	0,29	-0,42	27,7±1,3	26,0±1,0	20,2±1,0
Stress Index Baevsky, un.	0,07	6,8	10^{-5}	-0,06	0,007	0,20	-0,29	128±15	116±11	72±9
Systolic BP, mm Hg	0,05	5,5	10^{-5}	0,05	-0,02	0,08	-0,03	126±6	121±5	118±3
Plasma Uric acid, µM/l	0,34	9,4	10^{-5}	-0,009	-0,001	-0,24	-0,02	232±19	318±26	329±23
HRV TI, units	0,06	6,4	10^{-5}	-0,08	-0,56	-0,19	0,33	10,1±0,6	10,6±0,4	13,9±1,1
Mg-ATPase, M_{Ph}/l•h	0,05	5,9	10^{-5}	-2,58	2,33	-0,11	0,02	0,87±0,06	0,98±0,05	1,03±0,10
Ca-ATPase, M_{Ph}/l•h	0,11	6,2	10^{-5}	-2,31	0,03	-0,06	0,09	0,99±0,17	1,03±0,16	1,22±0,12
Amplitude of Moda, %	0,22	9,3	10^{-5}	-0,32	-0,37	0,19	-0,57	43,5±1,6	45,6±1,3	33,5±2,2
SDNN, ms	0,13	6,7	10^{-5}	0,14	0,08	-0,15	0,40	47±3	45±2	61±4
Height, cm	0,18	8,2	10^{-5}	0,235	0,225	0,03	0,24	164±1	160±1	164±2
Plasma Potassium, mM/l	0,15	7,3	10^{-5}	0,16	0,61	0,03	0,13	4,37±0,22	4,02±0,29	4,34±0,24
Plasma Phosphates, mM/l	0,04	5,4	10^{-5}	-2,56	-0,29	0,05	0,03	1,00±0,07	0,91±0,12	0,92±0,10
Chi-square tests with successive roots removed	Constant			-61,4	-27,7			Means of canonical variables		
	$r_1^*=0,94$; Wilks' Λ=0,04; $\chi^2_{(24)}=70$; $p<10^{-5}$						Root 1	+3,60±0,31	-1,29±0,38	-2,22±0,28
	$r_2^*=0,82$; Wilks' Λ=0,32; $\chi^2_{(11)}=24$; p=0,012						Root 2	+0,28±0,38	-1,98±0,31	+1,36±0,26

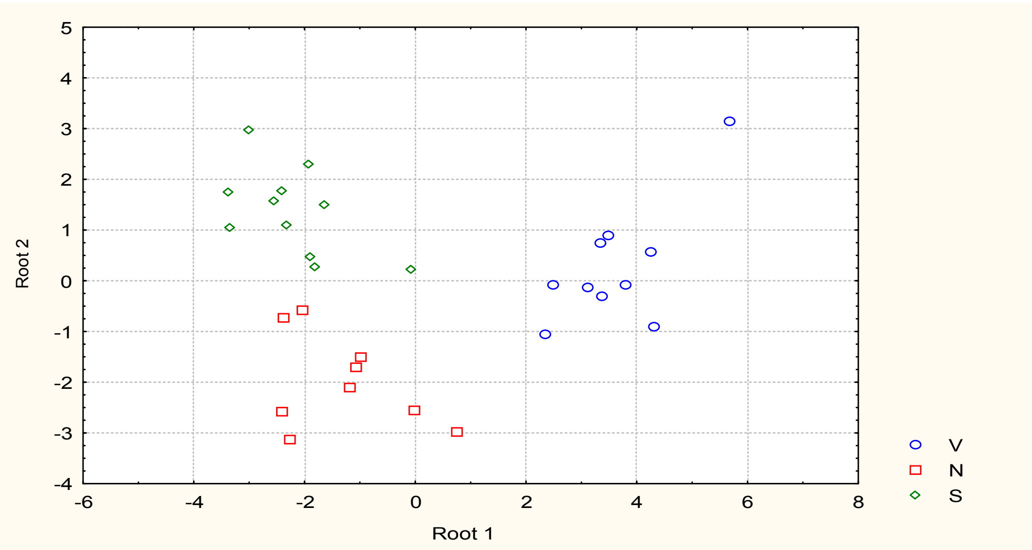

Figure 25. Unstandardized canonical scores of roots of parameters-predictors for various vegetotropic effects of bioactive water Naftussya

D^2_M between clusters V and N average 32,3 (F=6,8; $p<10^{-3}$), V and S: 39,0 (F=6,8; $p<10^{-4}$), N and S: 13,4 (F=2,9; p=0,023). Classification functions for forecasting of

Vagotonic effect:

131,0•Contract. Ind. – 4,92•Stress Index + 1,89•Syst. BP – 0,28•Uric acid -15,15•HRV TI – 73,3•Mg-ATP – 151,5•Ca-ATP – 24,7•AMo + 15,8•SDNN + 31,35•Height + 28,54•Potassium – 217,7•Phosphates – 3751

Neutral effect:

122,5•Contract. Ind. – 4,64•Stress Index + 1,70•Syst. BP – 0,23•Uric acid -13,50•HRV TI – 66,0•Mg-ATP – 140,3•Ca-ATP – 22,3•AMo + 14,9•SDNN + 29,69•Height + 26,40•Potassium – 204,5•Phosphates – 3385

Sympathotonic effect:

121,8•Contract. Ind. – 4,56•Stress Index + 1,59•Syst. BP – 0,22•Uric acid -15,31•HRV TI – 55,8•Mg-ATP – 138,0•Ca-ATP – 23,2•AMo + 15,1•SDNN + 30,22•Height + 28,30•Potassium – 203,1•Phosphates – 3421

From the combination of the identified predictors of a particular character vegetotropic effect of BAWN can be predicted accurately.

CONCLUSION

It is identified multivariate vegetotropic effects of a three-week course of drinking bioactive water Naftussya spa Truskavets. Found a strong canonical correlation between changes for parameters of heart rate variability, on the one hand, and changes for parameters of thyroide status, of excange of lipides and

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electrolytes as well as haemodynamic, on the other hand. Method of discriminant analysis shows that the total of 12 selected initial parameters of the body may infallible forecast vagotonic, neutral and sympathotonic vegetotropic effects of bioactive water Naftussya.

ACCORDANCE TO ETHICS STANDARDS

Tests in patients are conducted in accordance with positions of Helsinki Declaration 1975, revised and complemented in 2002, and directive of National Committee on ethics of scientific researches. During realization of tests from all participants the informed consent is got and used all measures for providing of anonymity of participants.

For all authors any conflict of interests is absent.

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Дата поступлення: 01.08. 2013 р.

UDC: 616.003.96-616.45-001.1/3-616-084

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