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CONTENTS

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REPRODUCTIVE PHENOLOGY AND FRUIT GROWTH DYNAMICS OF *YUCCA* L. CULTIVARS INTRODUCED IN THE CRIMEA

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Introduction

Yucca L. cultivars are highly ornamental arboreal and shrubby plants, that make parks on South Coast of the Crimea (SCC) particularly exotic. Importance of this research is undoubted, as mass introduction of yucca cultivars will be able to increase plantation ornamentality of SCC. Research subject possesses scientific novelty and practical value. Scientific novelty is that for the first time as a result of different methods of yucca controlled pollination, there are fruits with viable seeds and now plants which take quite important stage in SCC landscaping. Practical value of our results is enrichment of all plantations on SCC by exotic arboreal and shrubby plants – for benefit of yucca ornamental and aesthetic value.

Objects and methods of the research

Objects of our researches were specimens of 10 cultivars and 3 forms of yucca garden cultivars, that were introduced on SCC, many parks of the Crimea and Sevastopol in different period. All these cultivars and forms have strong morphological distinctions. Inspectation of the Crimean ornamental plantations, that took place in 1986-1988 didn`t result any other new yucca cultivars. Therefore, NBG collection includes all yucca cultivars growing on SCC, moreover there are unique cultivars presented with 1 specimen not only in the Crimea, but all over countries of former USSR [2].

During vegetative periods – 1984, 1995, 2001, 2006 and 2014 we conducted a complex of researches, aimed at seed propagation of different yucca cultivars and garden forms and their industrial cultivation. To achieve this purpose, since spring 1984 controlled pollination of flowers of all yucca cultivars growing in the Crimea was carried out. But in spring 1984 *Y. carnerosana* was capable to yield fruits with viable seeds exclusively due to our new method of controlled pollination of hard-pollinated yucca cultivars [1]. Figure and table of fruit growth dynamics present all necessary data about reproductive phenology and fruit growth dynamics, that is possible and certain key point for terms of controlled pollination of yucca cultivars and garden forms growing in the Crimea. Since spring 1984 till spring 2014 annual measurements of fruit growth were conducted for *Y.aloifolia, Y.aloifolia 'Marginata'* and *Y.aloifolia 'Tenuifolia'* as this very cultivar and its garden forms set fruits with viable seeds annually being pollinated naturally. Controlled pollination of other yucca cultivars wasn`t successful because of climatic conditions. But their complete growth pattern during certain periods were determined quite exactly.

Peculiarities of *Y. Carnerosana,* as an arboreal plant is its complicated pollination, what is labour-intensive and dangerous, as controlled pollination according to our discovered method was to realize at altitude of 5 m or more for some hours. And only due to applied new

method of controlled pollination in 1984-1986 fruits with viable seeds were successfully obtained.

Results and discussion

Growth and development of yucca fruits weren`t practically investigated. In case of juicy fruits there is enlargement of overy tissue stimulated by pollination, and development of germ and endosperm. Growth of the most fruits is presented by simple S-curve. At the beginning size increasing occurs by exponential law but later it slows down [3].

Instrument measurement with hand caliper was applied for fruit growth dynamics of yucca cultivars. It was carried out daily in the morning after controlled pollination procedures in NBG and other parks of the Crimea and Sevastopol. The way of fruit growth defines either cell distension or cytocinesis.

Phenological observation of reproduction sphere which is determined for cultivar characteristic and its value rating for ornamental gardening on SCC, was defined due to actual data, presented at figure and in table below.

Other yucca cultivars that set fruits with viable seeds as a result of common method of controlled pollination didn`t change its sex identity during our phenological investigations. In spite of that representatives of yucca genus are monoecious hermaphrodite, special deflections in their sexual identity were not fixed for 30 years of observations. Those specimens, which were found as male and female for convenience, didn`t change their sex identity during their development. These facts concern *Y. Carnerosana* as well. Moreover yucca cultivars presented in the list, but growing in other climatic zones of the Crimea followed the same manner of development [4, 5]. Polytomous key for *Yucca* L. cultivar identification by fruits, introduced in the Crimea, was published by our group before [6]. That`s why description of all elements of yucca cultivar fruit was omitted in this article.

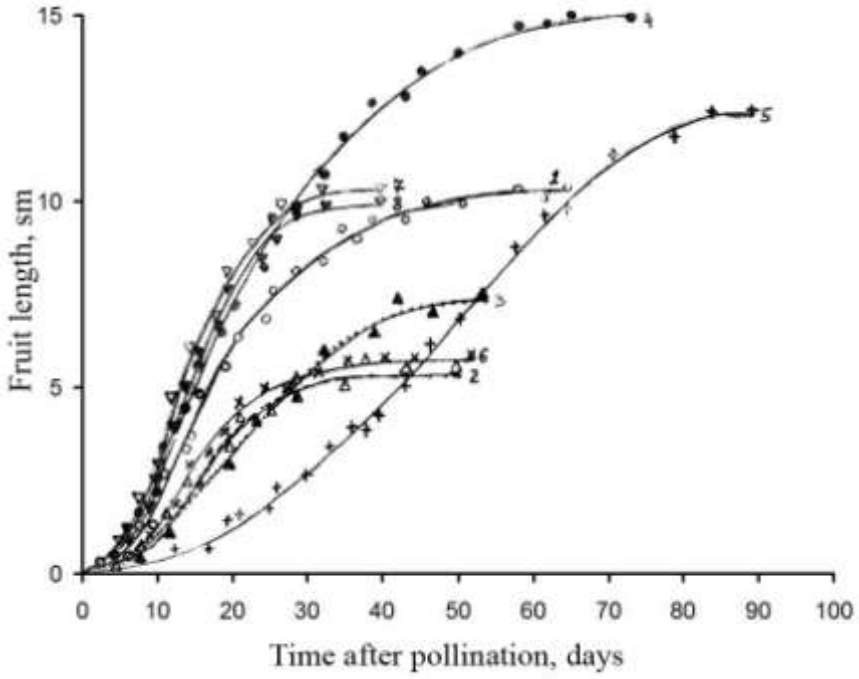

Fig. Fruit growth dynamics of yucca cultivars (Yucca L.) *

1. *Y. treculeana* - ○ 2. *Y. recurvifolia* - △ 3. *Y. aloifolia* - ▲ 4. *Y. pallida* – ●

5. *Y. carnerosana* - ✚ 6. *Y. filamentosa* - ✖ 7. *Y. elata* - ▽ 8. *Y. glauca* – ▼

* - Each symbol corresponds to arithmetical mean of 10 fruits.

Table

Findings of reproductive phenology of *Yucca* cultivars in Nikita Botanical Gardens on South Coast of the Crimea and in Sevastopol dated by 1984-2015

Yucca cultivars	Germination of a flower stalk	Branching of flower stalks	Blossoming, Beginning end	Fruit inception, beginning end	Fruit ripening, beginning end	Visible vegetation, beginning end
1	2	3	4	5	6	7
Yucca aloifolia* L.	16.08	19.08	23.08 02.09	24.08 05.09	14.11 05.12	21.04 10.12
Y. aloifolia 'Marginata' *	15.08	20.08	23.08 01.09	25.08 03.09	15.11 03.12	20.04 10.12
Y. aloifolia 'Tenuifolia' *	16.08	20.08	22.08 02.09	25.08 04.09	15.11 04.12	21.04 10.12
Y. carnerosana* Carr.**	29.04	14.05	16.05 02.06	18.05 04.06	31.08 28.09	15.04 15.11
Y. elata* Engelm.*	20.05	26.05	02.06 29.06	02.06 30.06	04.09 21.09	15.05 30.09
Y. filamentosa* L.*	14.05	16.05	18.05 14.06	20.05 16.06	14.09 16.10	22.04 18.11
Y.flaccida* Haw.*	15.05	17.05	19.05 14.06	21.05 15.06	15.09 15.10	21.04 16.11
Y. glauca* Nutt.*	24.05	03.06	04.06 22.06	06.06 24.06	12.09 28.09	13.05 30.09
Y. gloriosa* L.*	13.05 29.08 18.10 20.12	17.05 03.09 25.10 27.12	21.05 01.06 05.09 21.09 30.10 20.11 29.12 Flower stalks having got frozen	22.05 03.06 20.05 05.06 – –	15.09 10.10 – – –	21.04 20.11 – – –
Y.pallida* McKelvey*	18.05	25.05	02.06 12.06	04.06 14.06	28.09 30.10	05.05 18.11
Y.recurvifolia* Salisb.*	12.05 28.08 20.10 18.12	18.05 02.09 26.10 28.12	20.05 02.06 04.09 22.09 29.10 21.11 30.12 20.02 Flower stalks having got frozen	21.05 04.06 – – –	14.09 12.10 – – –	20.04 19.11 – – –
Y.treculeana* Carr.*	08.05	16.05	19.05 08.06	20.05 11.06	21.09 18.10	16.04 04.11
Y.treculeana 'Canaliculata'*	05.05	14.05	16.05 02.06	16.05 11.06	21.09 10.10	05.05 12.11

*Fruit setting with viable seeds naturally. But the mechanism of this process is still unknown. Almost annually we observed all these parameters of these taxons allowing for time factor.

** Fruit setting with viable seeds due to common method of controlled pollination. We carried it out in 1985, 1995, 2001, 2006 and 2014.

*** Fruit setting with viable seeds due to invented method of controlled pollination, which was applied with this cultivar of *Yucca* in 1984-1986.

As a result of data analysis it was found out that ***Y. Carnerosana*** starts blossoming first (since April the 29th). Period from the germination of terminal inflorescence till its branching and blossoming takes 15-18 days. Blossoming continues 16 days. After controlled pollination by invented method in 3-5 days flowers set fruits, that in 90 days stop growing and ripen completely. A number of seeds in a fruit ranges from 90 till 160.

Y. treculeana and ***Y. treculeana 'Canaliculata'*** form flower stalks the second (since May the 5th). Period from flower stalk germination till its branching and blossoming takes 9-12 days. Blossoming lasts 17-21 days. Fruit setting occurs in 1-3 days being artificially pollinated by common method. Fruit ripening starts in 62 days after their setting. A number of seeds in a fruit ranges since 49 till 150.

Y. recurvifolia relieves flower-bearing stems growing since May the 12th as a rule, laterals appear in 7 days and 2-3 days later it starts blossoming. Blossoming period lasts 12 days. After common controlled pollination fruits set in 1 day. Fruit ripening occurs in 50 days after their setting. A number of seeds per one fruit gets 150-300. Usually blossoming time of this yucca cultivar can be divided into 4 terms, every 2-3 months, but as a result of controlled pollination the next 3 terms, besides the first one, weren`t marked with fruit setting. In this way during the fourth term of blossoming (in winter) flower-bearing stems got frozen.

Y. gloriosa and ***Y. filamentosa*** are almost similar according to phenological terms. Since germination (May the 13th) with its further branching till the first flowers get blossoming it takes 5 days. Blossoming period ranges from 10 to 23 days. Fruits with viable seeds are set in case of common controlled pollination only. 50-52 days pass since fruit setting till fruit ripening. A number of seeds per one fruit, that ranges from 100 till 250, isn`t distinctive feature for these cultivars. But as opposed to ***Y. filamentosa,*** blossoming of ***Y. gloriosa*** passes 3-4 terms, and fruits – as a result of the common controlled pollination are possible during the first term only (like for *Y. Recurvifolia)*. Moreover winter flowering of this yucca cultivar occurs under sub-zero conditions, that`s why flower-bearing stems get frozen.

Y. pallida is characterized by flower-bearing stems setting since May the 18th , their branching occurs in 5-7 days, while blossoming starts in 7 days and lasts 10 days. As a result of the common controlled pollination fruit setting happens in 2-3 days. Period of fruit ripening takes 72 days. A number of seeds per fruit gets 100-250.

For ***Y. elata*** flower-stem setting is typical since May the 20 and in 5-6 days they branch out and in one week blossoming takes place and lasts 31 days. After common controlled pollination set fruits ripen in 38 days. A number of seeds per a fruit ranges from 150 till 350.

Y. glauca set flower-bearing stems in the end of May. Branching occurs in 9 days, blossoming starts in 1-2 days and lasts 18 days. Common controlled pollination was also applied for this yucca cultivar and in 1-2 days fruits were set with further ripening in 42 days. A number of seeds per one fruit reaches 100-350.

Y. flaccida is characterized by the same reproductive phenology as *Y. filamentosa.* A number of seeds per one fruit ranges from 100 till 250.

Y. aloifolia, ***Y. aloifolia 'Marginata'*** and ***Y. aloifolia 'Tenuifolia'*** has the first and the only blossoming period in the middle of August and lasts 10-12 days on the whole. Period from flower-bearing stems setting till the first flowers takes 8-9 days. Fruit setting of this

cultivar and its ornamental forms occurs even without controlled pollination, however this phenomena is still unknown. Fruits ripen in 53 days. A number of seeds per one fruit is from 80 till 200.

Fruit growth dynamics of all yucca cultivars and garden forms takes S-shaped curve by exponential law with its further slowdown.

The largest fruits with more seeds set at the bottom of branch (elementary inflorescence) that is near flower-bearing stem (main inflorescence) on its bottom. As far as reaching the end of branch and the end of flower-bearing stem fruit size becomes smaller and a number of seeds decreases. Fruits can be quite often deformed and according to our long-term observations in this case, having carried out controlled pollination, 70-90% of pollen are inviable or there is a lack of it. More pollen or its better quality, used during controlled pollination, stimulating fruit size and a number of seeds there. While preparing fruits of various yucca cultivars and forms it was found out their length and form directly depend upon topography of seeds set in a fruitcase. Seed size determines fruit diameter and in case of full fruitcase it`s the same in spite of any fruit length allowing for certain yucca cultivar. If a fruitcase is partly filled (one-sided) by seeds their diameter can have a smaller size. Seed length, thickness, width, form and weight depend upon their position in a fruitcase. Typical triangular and flat seeds are located in the centre of a fruitcase and make 60-90% of a total number in a fruit. In the end of a fruit there are seeds that have pyramid or other more unusual shapes, that were formed in tight conditions of narrowing fruitcase. Seed weight isn`t determined by its length, thickness, width and form.

Conclusions

1. On South Coast of the Crimea (Nikita Botanical Gardens) *Y. Carnerosana* opens *Yucca* blossoming season and after it the following cultivars continue it: *Y. treculeana, Y. treculeana 'Canaliculata', Y. recurvifolia, Y. gloriosa, Y. filamentosa, Y. flaccida, Y. pallida, Y. elata,* and *Y. Glauca.* It`s worth to point out that all cultivars blossoming lasts during two months without a break having crossed flowering terms. *Y. aloifolia, Y. aloifolia 'Marginata'* and *Y. aloifolia 'Tenuifolia'* are ready to blossom only 1,5 months after blossom fading of others – from the middle of August – the most popular holiday season. Flowers are mainly white (neutral), but some garden forms *Y. gloriosa* – sulphureous and pink-yellow, that harmonize with various ornamental trees and bushes blossoming in the same period. Repeated blossoming terms of *Y. gloriosa* and *Y. Recurvifolia* sometimes coincide with blossoming terms of *Y. aloifolia, Y. aloifolia 'Marginata'* and *Y. aloifolia 'Tenuifolia'* that supplies color spectrum of evergreen and deciduous plants being in blossom during this period by neutral component. In other regions of South Coast of the Crimea and in Sevastopol having less number of yucca cultivars (*Y. treculeana, Y. recurvifolia, Y. gloriosa, Y. filamentosa, Y. flaccida, Y. elata, Y. glauca)* phenological terms of blossoming fruiting coincide with terms, registered in Nikita Botanical Gardens. Reproductive phenology parameters of different specimens within one cultivar can differ from selected patterns by terms ± 6-11 days.

2. Fruit growth dynamics of yucca cultivars develops according to exponential law and presents S-curve. *Y. Carnerosana,* in comparison with other yucca cultivars, fruit growth rate increases gradually and gets maximum when 2/3 of the ripening period has passed. *Y. pallida, Y. treculeana,* and *Y. Aloifolia* form pulpy fruitcases (including *Y. carnerosana*), have more prolonged ripening term for fruits with viable seeds (53-90 days). Yucca cultivars that form dry fruitcases have not so long period of fruit ripening with viable seeds *(Y. recurvifolia, Y. filamentosa,Y. elata, Y. glauca)* – 38-52 days. According to average fruit length that ranges from 5 till 15 sm depending upon cultivar, as far as their size decreases there is a line of yucca cultivars: *Y. pallida* – 15 sm, *Y. carnerosana* – 13 sm, *Y. elata* – 10

sm, *Y. treculeana* – 10 sm, *Y. glauca* – 9 sm, *Y. aloifolia* – 7 sm, *Y. filamentosa* – 6 sm, *Y. recurvifolia* – 5 sm.

3. Controlled pollination of all yucca cultivars is better to carry out during the first half of blossoming what allows to get larger fruits with more seeds. For controlled pollination of pistil of one flower it`s recommended to use pollen of all six stamens of this flower in case of autogenous or six stamens of other flower if geitonogenous, xenogenous and hybridgenous. That favors a high level of ovule fecundation and later larger fruits with more viable seeds. Controlled pollination of one main and the rest of its elementary inflorescences mustn`t be more than 10% of flowers as a plant having a lack of pollinated flowers rejects flower-bearing stem as it is. If 100% pollination, a plant rejects ¼ of set fruits or all fruits get small size and contain less than usually viable seeds. There is a sense to carry out controlled pollination of 70-80% flowers of 1 main and all of its elementary inflorescences.

References

1. *Golubyev V.N., Maksimov A.P., Volokitin Yu.S., Novikova V.M.* Avtorskoye svidetelstvo SSSR na izobreteniye № 1470205, kl. A 01 H 1/02. – 1988.

2. *Kuznetsova V.M., Maksimov A.P., Sokolov B.I.* Drevesniye rasteniya v sadu kruglogodichnogo tsveteniya // Bull. Glavnnogo botan.sada. – 1988. – Vyp. 148. – S. 38-44.

3. *Leopold A.* Rost i razvitiye rasteny. – M.: Myr, 1968. – 494 s.

4. *Maksimov A.P., Mukhortova Ye.G., Novikova V.M., Kuznetsova V.N.* Bioekologicheskiye osobennosti i kachestvo semyan vidov *Yucca* (Dill.) L., introdutsirovannyh v Krymu // Rastitelniye resursy. – 1988. – T. 24, vyp.2. – S. 230-237.

5. *Maksimov A.P., Novikova V.M., Mukhortova T.G., Volokitin Yu.S.* Perspektivy vnedreniya vidov yukki (*Yucca* L.) v ozelenenii // Bull. Gos. Nikitskogo botan sada. – 1987. – Vyp.64. – S. 29-33.

6. *Maksimov A.P., Volokitin Yu.S.* Polytomichesky klyuch dlya opredeleniya po plodam vidov *Yucca* L., introdutsitovannyh v Krym // Rastitelniye resursy. – 1990. – T. 26, vyp. 3. – S. 382 – 387.

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Average long-term data are presented for the first time for 30-years study of reproductive phenology and fruit growth dynamics of 10 cultivars and 3 garden forms of *Yucca,* that were bred either by natural fruit-set with viable seeds or by habitual method of controlled-pollination. *Yucca carnerosana* is of special importance in this way, as it`s capable to set fruits only by discovered method of controlled-pollination (A.S. № 1470245 USSR, 1988). Controlled-pollination, phenologic observations and study of fruit growth dynamics of *Yucca* cultivars were carried out since 1984 till 2014, that period was broken into 5 terms (1984, 1995, 2001, 2006 and 2014). Plants of Nikita Botanical Gardens, Crimean and Sevastopol parks were used as study cases. The article reports about peculiarities of fruit setting, allowing for their morphological characteristics and cultivar belonging.

Key words: *reproductive phenology, fruit growth dynamics, Yucca cultivars, methods of controlled-pollination, the Crimea.*

HUMAN PHYTOREHABILITATION

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ESSENTIAL OIL OF *EUCALYPTUS* AND ITS EFFECT ON PSYCHOPHYSIOLOGICAL STATE OF PEOPLE BREATHING IT IN DIFFERENT CONCENTRATION DURING EXERCISE

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Introduction

Essential oil (EO) of *Eucalyptus* (*Eucalyptus globulus, Eucalyptus cinerea,, Eucalyptus viminalis*) is mainly used as antiseptic and anti-inflammatory remedy [4]. But at the same time it affects on nervous system as well [5]. It was demonstrated that breathing eucalyptus EO of 1 mg/m^3 during rest time, it improves psychoemotional state and has a hypotensive and bradicardial effect [3].

Objective of this work is to investigate effect of eucalyptus EO being in different concentrations on some functions of human central nervous system and cardiovascular system during exercise.

Objects and methods

A group of 20 women aged by 20-50 was involved into this study. Control one was similar group by composition and size. 90-minute exercise at eastern dances was chosen as a physical load. In a control group the exercise was held without extra effects. People of experimental group could breath *Eucalyptus* EO of the following concentrations: 0,5; 1,0 or 2,0 mg/m^3.

WAM (well-being, activity, mood) test was to assess EO effect on nervous system [1, 2], for cardiovascular system we measures heart rate (HR), systolic (BPS) and diastolic (BPD) blood pressure.

Nervous system parameters were tested before and after exercise, cardiovascular system – before and after exercise and 15 minutes later.

Findings were processed statistically applying t-criterion by Student for associated and independent sampling.

Results and discussion

According to parameter of WAM test initially experimental group, having done exercise under influence of *Eucalyptus* EO, 2,0 mg/m^3, and control group didn`t have any reliable differences (table 1).

After exercise without extra effect of *Eucalyptus* EO (control group) there was a reliable improvement of general condition, mood and rise of vivacity . That is dance session demonstrates euphoric effect.

Atmosphere concentrated with eucalyptus EO provoked reliable increasing of the most study parameters, besides vivacity and attentiveness. These both parameters had a

tendency to improve. On the whole dance session held with *Eucalyptus* EO, 2,0 mg/m^3, resulted improvement of psychoemotional state of tested people like it was in a control group.

Table 1

Effect of *Eucalyptus* EO, 2,0 mg/m^3, on psychoemotional state of tested people (test WAM parameters, standard units)

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pc b/a<
General condition	148,60 ±4,27	144,75 ±7,85	162,40 ±4,61	0,003	153,30 ±5,94	0,02
Well-being	147,15 ±6,64	142,65 ±8,83	161,60 ±4,50	0,04	152,35 ±7,02	0,05
Mood	144,30 ±6,71	150,45 ±6,76	172,40 ±5,14	0,000002	160,95 ±4,79	0,003
Weakness - capacity to work	134,65 ±6,42	140,10 ±8,02	150,75 ±5,96	0,02	141,35 ±6,51	0,84
Tension – relaxation	142,30 ±5,69	134,30 ±4,89	154,70 ±4,97	0,03	143,45 ±6,59	0,20
Inertness –vivacity	133,85 ±6,19	128,70 ±8,01	147,80 ±5,89	0,06	145,05 ±6,62	0,01
Absent-mindedness – attentiveness	133,05 ±5,40	129,70 ±7,91	144,10 ±5,09	0,07	139,80 ±5,18	0,11

Experimental group, being under effect of eucalyptus EO, 1,0mg/m^3 and control group didn`t have any reliable differences (table 2).

Table 2

Effect of *Eucalyptus* EO, 1,0 mg/m^3, on psychoemotional state of tested people (test WAM parameters, standard units)

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pc b/a<	Pex/c after<
1	2	3	4	5	6	7	8
General condition	150,65 ±7,11	157,30 ±5,16	176,84 ±4,94	0,0001	162,65 ±5,13	0,02	0,1
Well-being	155,40 ±8,87	157,50 ±4,93	183,93 ±5,60	0,0007	164,85 ±4,54	0,01	0,05
Mood	161,60 ±5,85	166,35 ±4,37	185,37 ±3,71	0,00002	169,95 ±3,37	0,003	0,01
Weakness - capacity to work	149,70 ±10,51	151,80 ±5,87	182,65 ±5,91	0,0005	152,75 ±5,74	0,37	0,01
Tension – relaxation	136,00 ±5,70	132,00 ±5,10	152,85 ±5,18	0,0001	149,70 ±6,25	0,09	
Inertness – vivacity	137,50 ±11,41	141,05 ±6,67	175,71 ±7,63	0,0002	155,50 ±4,55	0,004	0,05
Absent-mindedness – attentiveness	142,50 ±9,11	144,30 ±5,65	172,86 ±6,74	0,0007	144,80 ±4,14	0,05	0,01

After exercise without essential oil (control group) reliable rise of general condition, well-being, mood, vivacity and attentiveness was registered. Tension tended to decrease.

After dance session held in a room concentrated with *Eucalyptus* EO (experiment group), 1,0 mg/m^3 there was a pronounced improvement of all study parameters: general

condition, well-being, mood, capacity to work, vivacity, attentiveness, tension. In this case finite value of well-being, mood, capacity to work, vivacity, attentiveness in experimental group was higher than in control group; general condition kept the tendency of increasing.

Otherwise dance session held in the room concentrated with *Eucalyptus* EO, 1,0 mg/m^3 resulted pronounced and much more emphasized improvement of human psychoemotional state in comparison with control group.

Investigating effect of *Eucalyptus* EO of 0,5 mg/m^3 according to WAM test, both groups didn`t have any reliable differences (table 3).

Table 3

Effect of *Eucalyptus* EO, 0,5 mg/m^3, on psychoemotional state of tested people (test WAM parameters, standard units)

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pc b/a<
General condition	154,25 ±5,93	157,30 ±5,16	161,55 ±6,19	0,01	162,65 ±5,13	0,12
Well-being	154,80 ±5,66	157,50 ±4,93	163,70 ±5,46	0,001	164,85 ±4,54	0,02
Mood	160,25 ±6,06	166,35 ±4,37	169,10 ±5,86	0,0003	169,95 ±3,37	0,13
Weakness –capacity to work	146,15 ±5,90	151,80 ±5,87	149,95 ±4,73	0,47	152,75 ±5,74	0,91
tension – relaxation	138,45 ±4,48	132,00 ±5,10	156,10 ±5,89	0,002	149,70 ±6,25	0,04
Inertness – vivacity	140,35 ±6,72	141,05 ±6,67	146,15 ±6,49	0,18	155,50 ±4,55	0,05
Absent-mindedness – attantiveness	142,30 ±7,15	144,30 ±5,65	149,29 ±6,32	0,18	144,80 ±4,14	0,94

After exercise without essential oil (control group) there was a reliable rise of well-being, vivacity and slowdown of tension.

After dance session with essential oil (experimental group) a reliable improvement of general condition, well-being and mood was fixed, while level of tension went down. At the same time finite values of parameters in both groups are close.

On the whole dance session held in the room concentrated with *Eucalyptus* EO, 0,5mg/m^3 didn`t result significant improvement of psychoemotional state in comparison with value of control group.

While studying effect of *Eucalyptus* EO, 2,0 mg/m^3, on cardiovascular system initially (before procedure) there weren`t any reliable differences between values of BP and HR in control and experimental groups (table 4). In this case in both groups average values of BPS and BPD were normal by JNC6, HR – higher.

After dance session without EO (control group) values of BPS and BPD didn`t change, HR had a reliable rise, and 15 minutes later became as it was initially.

Value of HR raised for certain, 15 minutes later slowdown back. *Eucalyptus* EO of 2,0mg/m^3 didn`t have any effect on cardiovascular system.

Table 4

Effect of *Eucalyptus* EO, 2,0mg/m^3 on blood pressure (mm of mercury) and heart rate (bpm) during exercise

Parameter	Before procedure	After procedure	P<	In 15 min after procedure	Before proced. / in 15 min after procedure P<	After procedure. / in 15 min after procedure P<
BPS Experimental group	123,90 ±2,47	122,80 ±1,80	0,62	123,30 ±2,19	0,75	0,85
BPS Control group	126,25 ±3,73	129,10 ±3,58	0,43	126,25 ±3,49	1,00	0,34
BPD Experimental group	80,80 ±1,83	82,55 ±1,42	0,24	82,65 ±1,64	0,27	0,94
BPD Control group	83,25 ±2,54	85,70 ±1,28	0,14	85,45 ±2,05	0,15	0,86
HR Experimental group	85,45 ±3,03	93,00 ±3,16	0,03	89,20 ±2,33	0,13	0,08
HR Control group	86,85 ±3,18	95,80 ±3,69	0,03	88,00 ±3,31	0,74	0,001

While studying effect of *Eucalyptus* EO, 1,0 mg/m^3 on cardiovascular system it was found out that initially BPS and BPD in both groups were between normal and high values by JNC6, HR was higher. Certain differences between initial values of BP and HR weren`t fixed either in control group or in experimental one (table 5).

After dance session without essential oil (control group) value of BPS didn`t change, BPD tended to increase. Value of HR rose for certain. In 15 minutes after dance class BP was on the same level as it was registered just after exercise, HR value turned back.

In the experimental group after dance session in the room concentrated with *Eucalyptus* EO BPS decreased, while BPD was kept on the same level. In 15 minutes after dance class BPS value was the same as just after exercise and lower in comparison with initial data. Values of BPD didn`t differ much from initial and values just after dance class. HR value just after dance increased and in 15 minutes it went down, but tended to rise in comparison with initial data.

Table 5

Effect of *Eucalyptus* EO, 1,0 mg/m^3 on blood pressure (mm by mercury) and heart rate (bpm) during exercise

Parameter	Before procedure	After procedure	P<	In 15 min after procedure	Before proced. / in 15 min after procedure P<	After procedure. / in 15 min after procedure P<
BPS Experimental group	130,10 ±4,21	122,90 ±2,88	0,03	123,80 ±3,93	0,04	0,70
BPS Control group	132,05 ±5,04	131,20 ±3,84	0,83	128,95 ±3,88	0,47	0,40
Pex/c	>0,1	<0,1	-	>0,1	-	-
BPD Experimental group	86,15 ±2,49	85,60 ±2,51	0,60	82,60 ±3,03	0,06	0,08
BPD Control group	84,55 ±3,07	87,65 ±2,52	0,09	87,45 ±2,30	0,11	0,88
Pex/c	>0,1	>0,1	-	>0,1	-	-
HR Experimental group	80,20 ±3,50	85,60 ±3,70	0,04	83,75 ±2,56	0,07	0,40
HR Control group	83,45 ±2,56	95,85 ±3,81	0,004	88,15 ±3,42	0,14	0,001
Pex/c	>0,1	<0,1	-	>0,1	-	-

Investigating effect of *Eucalyptus* EO, 0,5mg/m^3 on cardiovascular system, initially values of BPS and BPD in both groups were normal by JNC6, but HR was higher. Certain differences of BP and HR values between control and experimental groups weren`t fixed (table 6).

After dance session without EO (control group) values of BPS and BPD didn`t differ from initial data for certain. HR after dance class increased and in 15 minutes was back.

In experimental group after dance session in the room concentrated with *Eucalyptus* EO values of BPS, BPD and HR increased significantly. In 15 minutes after dance class BPD and HR were back to initial data, BPS was kept hightened.

Table 6

Effect of *Eucalyptus* EO, 0,5 mg/m^3 on blood pressure (mm by mercury) and heart rate (bpm) during exercise

Parameter	Before procedure	After procedure	P<	In 15 min after procedure	Before proced. / in 15 min after procedure P<	After procedure. / in 15 min after procedure P<
1	2	3	4	5	6	7
BPS Experimental group	120,70 ±2,38	128,95 ±3,39	0,02	125,90 ±2,91	0,04	0,18
BPS Control group	126,25 ±3,73	129,10 ±4,50	0,43	126,25 ±3,49	1,00	0,34
BPD Experimental group	80,40 ±1,44	84,55 ±1,66	0,002	80,90 ±1,96	0,69	0,002
BPD Control group	83,25 ±2,54	85,70 ±1,28	0,14	85,45 ±2,05	0,15	0,86
HR Experimental group	88,70 ±3,07	99,95 ±3,40	0,05	89,30 ±2,85	0,85	0,05
HR Control group	86,85 ±3,18	95,80 ±3,69	0,03	88,00 ±3,31	0,74	0,001

As a result it can be noticed that dance classes as they are provoke euphoric effect. Extra euphoric effect given by *Eucalyptus* EO reveals itself in case of higher study concentrations – 2,0 and especially 1,0 mg/m^3.

Influence of *Eucalyptus* EO on cardiovascular system is insignificant, varied and becomes apparent for account of BP and HR in case of lower study concentrations.

Conclusions

1. *Eucalyptus* EO provokes euphoric effect, that is pronounced during prolonged and medium exercise load in case of higher study concentrations only – 1,0 and 2,0 mg/m^3.
2. Effect of *Eucalyptus* EO on cardiovascular system is insignificant.

References

1. Osnovy psykhologii: Praktikum. / Red-sost. L.D. Stolarenko. – Rostov-na-Donu: Pheniks, 2002. – 704 s.
2. Praktikum po psykhologii./ Pod red.A.N. Leontjeva , B. Hyppenreiter. – Izd. Mosk. Un-ta, 1972. – 248 s.
3. *Tonkovtseva V.V., Dikhtyaruk M.V., Kosolapov A.N., Yarosh A.M.* Vliyaniye efirnogo masla evkalipta i psykhorelaksiruyushchei programmy na psykhophyziologisheskoye sostoyaniye cheloveka pri raznoy dlitelnosti vozdeistviya // Aromarelaksatsiya psykhophyzicheskogo sostoyaniya cheloveka: materialy 4-j Mezhdunarodnoy nauchno-prakticheskoy konferentsii (Yalta, 3-6 iyunya 2014). – Yalta, 2014. – S. 82-89.

4. *Babar Ali, Naser Ali Al-Wabel, Saiba Shams, Aftab Ahamad, Shah Alam Khan, Firoz Anwar* Essential oils used in aromatherapy: A systemic review // Asian Pacific Journal of Tropical Biomedicine. – 2015. - Volume 5. - Issue 8. – P. 601–611.

5. *Umezu T.* Evaluation of the effects of plant-derived essential oils on central nervous system function using discrete shuttle-type conditioned avoidance response in mice.// Phytother. Res. – 2012. – June. – 26(6). – P.884-891.

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Essential oil of *Eucalyptus* provokes euphoric effect during prolonged medium exercise; on the background of physical activity it is pronounced only in case of the highest study concentrations – 1,0 and 2,0 mg/m^3. Effect of *Eucalyptus* essential oil on cardiovascular system is insignificant and varied.

Key words: *essential oil, Eucalyptus, eastern dances, exercise load, psychoemotional state, WAM test, nervous system, cardiovascular system.*

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ESSENTIAL OIL OF *SYZYGIUM AROMATICUM* AND ITS EFFECT ON PSYCHOPHYSIOLOGICAL STATE OF PEOPLE BREATHING IT IN DIFFERENT CONCENTRATION DURING EXERCISE

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Introduction

Essential oil (EO) of *Syzygium Aromaticum* L. possesses neuroprotective, neurostimulating and tonic properties [5, 6]. It was demonstrated that breathing *Syzygium Aromaticum* L. EO of 1 mg/m^3 during rest time, it improves general state, well-being, mood and reduces anxiety and tension level, strengthens sense of vivacity, elation and attentiveness. BPD reduction was not much but significant, HR tended to decrease [2].

Objective of this work is to investigate effect of *Syzygium Aromaticum* L. EO being in different concentrations on some functions of human central nervous system and cardiovascular system during exercise.

Objects and methods

A group of 20 women aged by 20-50 was involved into this study. Control one was similar group by composition and size. 90-minute eastern dance class was chosen as a physical load. In a control group the exercise was held without extra effects, while people of experimental group could breath *Syzygium Aromaticum* L. EO of the following

concentrations: 0,5; 1,0 or 2,0 mg/m^3.

WAM (well-being, activity, mood) test was to assess EO effect on nervous system [3, 4], for cardiovascular system we measured heart rate (HR), systolic (BPS) and diastolic (BPD) blood pressure.

Nervous system parameters were tested before and after exercise, cardiovascular system – before and after exercise and in 15 minutes after the class finished.

Findings were processed statistically applying t-criterion by Student for associated and independent sampling.

Results and discussion

According to parameter of WAM test initially experimental group, having done exercise under influence of *Syzygium Aromaticum* L. EO, 2,0 mg/m^3, and control group didn`t have any significant differences (table 1).

After exercise without extra effect of *Syzygium Aromaticum* L. EO (control group) there was a significant improvement of mood and a tendency to improve general condition, well-being and rise of vivacity level. Otherwise a dance session as it is demonstrates euphoric effect.

Atmosphere concentrated with *Syzygium Aromaticum* L. EO provoked significant increasing of the most study parameters, besides capacity to work (tendency) and attentiveness. On the whole dance session held with *Syzygium Aromaticum* L. EO, 2,0 mg/m^3, resulted improvement of psychoemotional state of tested people like it was in a control group. But changes were more pronounced than in experimental group.

Table 1

Effect of *Syzygium Aromaticum* L. EO, 2,0 mg/m^3, on psychoemotional state of tested people (WAM test parameters, standard units)

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pc b/a<
General condition	151,60 ±6,60	150,50 ±6,56	163,00 ±5,48	0,004	155,40 ±5,30	0,09
Well-being	154,65 ±6,41	149,95 ±6,71	162,60 ±5,79	0,04	154,50 ±6,48	0,07
Mood	151,90 ±7,09	156,80 ±5,93	167,70 ±6,12	0,004	162,25 ±4,60	0,04
Weakness - capacity to work	140,80 ±5,83	146,75 ±6,86	154,65 ±5,96	0,06	143,50 ±6,35	0,60
Tension – relaxation	129,40 ±7,22	131,20 ±5,16	157,80 ±6,58	0,01	140,85 ±7,23	0,21
Inertness –vivacity	132,30 ±7,15	136,80 ±6,37	147,90 ±6,99	0,05	145,75 ±6,22	0,09
Absent-mindedness – attentiveness	138,50 ±6,75	137,10 ±6,33	144,00 ±6,79	0,43	139,50 ±4,96	0,65

According to WAM test initially experimental group having had a dance class in the room concentrated with *Syzygium Aromaticum* L., 1,0 mg/m^3 and a control group didn`t have any significant differences (table 2).

After class without EO control group demonstrated a rise of well-being, mood, vivacity and general condition tended to increase.

After dance class in the room concentrated with *Syzygium Aromaticum* L. EO experimental group actually demonstrated significant improvement of all these parameters: general condition, well-being, mood, attentiveness; vivacity tended to rise while tension had a

tendency to slowdown.

On the whole dance session held in atmosphere concentrated with *Syzygium Aromaticum* L. EO, 1,0mg/m^3 resulted significant improvement of psychoemotional state of test participants, as in a control group. In this way there was no marked difference between finite values of both groups.

Table 2

Effect of *Syzygium Aromaticum* L. EO, 1,0 mg/m^3, on psychoemotional state of tested people (WAM test parameters, standard units)

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pc b/a<
General condition	145,20 ±5,31	144,00 ±6,52	156,20 ±5,85	0,005	153,20 ±4,91	0,10
Well-being	147,35 ±5,73	144,30 ±6,34	158,00 ±5,90	0,002	155,40 ±5,28	0,05
Mood	143,50 ±6,76	154,60 ±5,36	159,80 ±5,91	0,002	161,85 ±4,03	0,02
Weakness - capacity to work	137,20 ±6,73	141,55 ±5,99	148,00 ±5,78	0,12	148,45 ±5,55	0,29
Tension – relaxation	132,70 ±7,62	129,25 ±4,98	145,90 ±6,52	0,07	141,30 ±7,19	0,12
Inertness – vivacity	135,45 ±6,59	129,45 ±6,76	148,15 ±5,58	0,10	151,60 ±5,75	0,01
Absent-mindedness – attentiveness	126,60 ±5,12	134,30 ±5,99	139,90 ±4,74	0,03	141,85 ±4,59	0,26

Investigating effect of *Syzygium Aromaticum* L. EO of 0,5 mg/m^3 according to WAM test, initially both groups didn`t have any significant differences (table 3).

Table 3

Effect of *Syzygium Aromaticum* L. EO, 0,5 mg/m^3, on psychoemotional state of tested people (test WAM parameters, standard units)

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pc b/a<
General condition	162,80 ±4,83	157,30 ±5,16	168,45 ±5,12	0,20	162,65 ±5,13	0,12
Well-being	157,85 ±5,71	157,50 ±4,93	169,15 ±5,77	0,03	164,85 ±4,54	0,02
Mood	164,50 ±4,23	166,35 ±4,37	174,30 5,13	0,06	169,95 ±3,37	0,13
Weakness –capacity to work	158,85 ±5,05	151,80 ±5,87	143,10 ±6,68	0,11	152,75 ±5,74	0,91
tension – relaxation	140,25 ±5,99	132,00 ±5,10	155,55 ±6,02	0,13	149,70 ±6,25	0,04
Inertness – vivacity	144,85 ±6,35	141,05 ±6,67	144,30 ±6,03	0,93	155,50 ±4,55	0,05
Absent-mindedness – attantiveness	143,90 ±6,13	144,30 ±5,65	141,85 ±5,01	0,63	144,80 ±4,14	0,94

After exercise without essential oil (control group) there was a significant rise of well-being, vivacity and slowdown of tension.

After dance session with essential oil (experimental group) positive changes were not

so pronounced as in control group: a significant improvement of well-being only, mood tended to rise.

While studying effect of *Syzygium Aromaticum* L. EO, 2,0 mg/m^3, on cardiovascular system initially (before procedure) there weren`t any significant differences between values of BP and HR in control and experimental groups (table 4). In this case in both groups average values of BPS and BPD were normal by JNC6, HR – higher.

After dance session without EO (control group) values of BPS didn`t change, BPD increased. In experimental group just after dance class with *Syzygium Aromaticum* L. EO BPS and BPD didn`t change. In 15 minutes BPS and BPD were back to initial and just after dance values.

Value of HR in both groups rose for certain, 15 minutes later slowed down, but stayed a little bit higher.

Table 4

Effect of *Syzygium Aromaticum* L. EO, 2,0mg/m^3 on blood pressure (mm of mercury) and heart rate (bpm) during exercise

Parameter	Before procedure	After procedure	P b/a<	P in 15 min after procedure<	P before proced. / in 15 min after procedure <	P after procedure. / in 15 min after procedure P<
BPS Experimental group	129,50 ±4,57	126,95 ±3,00	0,41	126,50 ±3,47	0,22	0,85
BPS Control group	128,10 ±4,23	131,50 ±3,70	0,28	130,20 ±4,08	0,44	0,68
BPD Experimental group	82,15 ±3,19	82,70 ±2,73	0,84	83,10 ±2,61	0,17	0,21
BPD Control group	85,85 ±3,17	88,85 ±2,89	0,04	87,85 ±2,54	0,18	0,40
HR Experimental group	83,25 ±2,72	91,70 ±2,83	0,01	87,55 ±2,41	0,08	0,03
HR Control group	84,50 ±3,22	94,27 ±3,55	0,02	87,37 ±3,15	0,39	0,001

While studying effect of *Syzygium Aromaticum* L. EO, 1,0 mg/m^3 on cardiovascular system it was found out that initially BPS and BPD in both groups were at high rate by JNC6, HR was higher. Certain differences between values of BP and HR weren`t fixed either in control group or in experimental one (table 5).

After dance session without essential oil (control group) value of BPS didn`t change, BPD tended to increase. In 15 minutes after dance class these values were on the same level as just after exercise.

In the experimental group after dance session in the room concentrated with *Syzygium Aromaticum* L. EO BPS decreased, while BPD was kept on the same level. In 15 minutes after dance class BPS value was the same as just after exercise, but lower in comparison with initial data. Values of BPD didn`t differ much from initial and values just after dance class.

HR value just after dance increased and in 15 minutes it went down, but stayed higher a bit in comparison with initial data.

Table 5

Effect of *Syzygium Aromaticum* L. EO, 1,0 mg/m^3 on blood pressure (mm of mercury) and heart rate (bpm) during exercise

Parameter	Before procedure	After procedure	P b/a<	P in 15 min after procedure <	P before proced. / in 15 min after procedure <	P after procedure. / in 15 min after procedure <
BPS Experimental group	140,20 ±5,67	124,35 ±3,76	0,0002	123,10 ±3,27	0,0001	0,63
BPS Control group	135,45 ±4,47	130,60 ±3,70	0,22	130,00 ±3,43	0,21	0,85
BPD Experimental group	89,10 ±3,22	90,25 ±3,07	0,65	86,80 ±3,02	0,17	0,21
BPD Control group	86,90 ±2,70	89,55 ±2,18	0,10	88,15 ±2,51	0,40	0,29
HR Experimental group	85,20 ±4,67	91,45 ±3,48	0,13	86,65 ±3,30	0,70	0,0003
HR Control group	89,75 ±3,37	94,25 ±3,43	0,17	85,65 ±2,52	0,12	0,0001

Investigating effect of *Syzygium Aromaticum* L. EO, 0,5mg/m^3 on cardiovascular system, initially values of BPS and BPD in both groups were normal by JNC6, but HR was higher. Certain differences of BP and HR values between control and experimental groups weren`t fixed (table 6).

After dance session without EO (control group) values of BPS didn`t differ from initial data for certain, but BPD had a significant rise. In experimental group after dance session held in the room concentrated with *Syzygium Aromaticum* L. EO values of BPS and BPD didn`t change. In 15 minutes after dance class BPS stayed as just after exercise in both groups, BPD tended to decrease in a control group.

HR values after dance class increased significantly either in control or in experimental group. In 15 minutes HR in a control group decreased for certain, but in experimental group it was kept heightened in comparison with initial data.

Table 6

Effect of *Syzygium Aromaticum* L. EO, 0,5 mg/m^3 on blood pressure (mm of mercury) and heart rate (bpm) during exercise

Parameter	Before procedure	After procedure	P b/a <	P in 15 min after procedure<	P before proced. / in 15 min after procedure <	P After procedure. / in 15 min after procedure <
1	2	3	4	5	6	7
BPS Experimental group	126,25 ±1,91	125,05 ±2,26	0,68	125,10 ±2,12	0,62	0,98
BPS Control group	127,95 ±4,15	131,20 ±3,84	0,33	128,60 ±3,67	0,84	0,47
BPD Experimental group	85,15 ±2,22	85,80 ±1,55	0,74	90,45 ±5,50	0,36	0,34
BPD Control group	83,60 ±2,87	87,40 ±2,39	0,03	86,80 ±2,26	0,06	0,58
HR Experimental group	81,90 ±3,57	94,65 ±3,20	0,00004	92,50 ±3,56	0,003	0,21
HR Control group	88,40 ±3,35	99,20 ±3,80	0,01	91,15 ±3,28	0,42	0,001

As a result it can be noticed that dance classes, as they are, provoke euphoric effect. Extra euphoric effect given by *Syzygium Aromaticum* L. EO reveals itself in case of the highest study concentration – 2,o mg/m^3.

Influence of *Syzygium Aromaticum* L. EO on cardiovascular system is significant in case of all study concentrations preventing BPD rise. If BPS is higher a bit (high rate by JNC6) EO demonstrates hypotensive effect. HR doesn`t react to *Syzygium Aromaticum* L. EO.

Conclusions

1. *Syzygium Aromaticum* L. EO provokes euphoric effect, that is pronounced during prolonged and medium exercise load in case of the highest study concentration only – 2,0 mg/m^3.
2. *Syzygium Aromaticum* L. EO possesses hypotensive action in case of prolonged medium exercise load.

References

1. *Lakin G.F.* Biometriya. – M.: Isd-vo “Vysshaya shkola”, 1989. – 291 s.
2. *Lapshun G.N., Tonkovtseva V.V., Yarosh A.M.* Vliyaniye efirnogo masla gvozdichnogo dereva na fone psykhorelaksatsionnoy programmy na psykhoemotsionalnoye sostoyaniye i serdechno-sosudistuyu sistemu cheloveka // Aromakorrektsiya psykhophizicheskogo sostoyaniya cheloveka: materialy 3-j mezhdunarodnoy nauchno-prakticheskoy konferentsii (Yalta, 4-7 iyunya 2013 goda). – Yalta, 2012. – S.52-56.
3. Osnovy psykhologii: Praktikum / Red.-sost. L.D. Stolyarenko. – Rostov-na-Donu: Pheniks, 2002. – 704 s.
4. Praktikum po psykhologii / Pod red. A.N. Leontjeva, B. Hyppenreiter. – Izd.

Mosk. Un-ta, 1972. – 248 s.

5. *Djilani A., Dicko A*. (2012). The Therapeutic Benefits of Essential Oils, Nutrition, Well-Being and Health, Dr. Jaouad Bouayed (Ed.), ISBN: 978-953-51-0125-3, InTech, Available from: http://www.intechopen.com/books/nutrition-well-being-and-health/the-therapeutic-benefits-of-essential-oils

6. *Kassab R.B., Bauomy A.A.* The neuroprotective efficency of the aqueous extract of clove (*syzygium aromaticum*) in aluninium-induced neurotoxicity // International Journal of Pharmacy and Pharmaceutical Sciences. – 2014. - *Vol 6. - Issue 5. – P. 503-508.*

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Essential oil of *Syzygium Aromaticum* provokes euphoric effect during prolonged medium exercise; on the background of physical activity it is pronounced only in case of the highest study concentration – 2,0 mg/m^3. Essential oil of *Syzygium Aromaticum* possesses hypotensive effect as well.

Key words: *essential oil, Syzygium Aromaticum, eastern dances, exercise load, psychoemotional state, WAM test, nervous system, cardiovascular system.*

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ESSENTIAL OIL OF *SALVIA SCLAREA* AND ITS EFFECT ON PSYCHOPHYSIOLOGICAL STATE OF PEOPLE BREATHING IT IN DIFFERENT CONCENTRATION DURING EXERCISE

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Introduction

Essential oil (EO) of *Salvia Sclarea* L. is used extensively in aromatherapy [4]. Its composition is quite close to *Lavandula officinalis* L. EO: principal components are linalyl acetate, linalool, geranilacetate and terpineol [5]. EO of *Salvia Sclarea* L. possesses antidepressive [6], stress limiting [7] and hypotensive [3] effects.

Objective of this work is to investigate if that`s possible to optimize human psychophysiological state during prolonged and medium exercise applying essential oil of *Salvia Sclarea* L.

Objects and methods of the research

A group of 20 women aged by 20-50 was involved into this study. Control one was

similar group by composition and size. 90-minute eastern dance class was chosen as a physical load. In a control group the exercise was held without extra effects. While people of experimental group could breath *Salvia Sclarea* L. EO of the following concentrations: 0,5; 1,0 or 2,0 mg/m^3.

WAM (well-being, activity, mood) test was to assess EO effect on nervous system [2, 3], for cardiovascular system we measured heart rate (HR), systolic (BPS) and diastolic (BPD) blood pressure.

Nervous system parameters were tested before and after exercise, cardiovascular system – before and after exercise and in 15 minutes after the class finished.

Findings were processed statistically applying t-criterion by Student for associated and independent sampling.

Results and discussion

According to parameter of WAM test initially experimental group, having done exercise under influence of *Salvia Sclarea* L. EO, 2,0 mg/m^3, and control group didn`t have any significant differences (table 1).

After exercise without extra effect of *Salvia Sclarea* L. EO (control group) there was a significant improvement of well-being, mood, vivacity, and a tendency to improve general condition. Otherwise a dance session, as it is, demonstrates euphoric effect.

Atmosphere concentrated with *Salvia Sclarea* L. EO provoked significant improvement of psychoemotional state by all study parameters. At the same time finite values of tension reduction and rise of vivacity were much higher in comparison with control group. On the whole dance session held with *Salvia Sclarea* L. EO, 2,0 mg/m^3, resulted significant improvement of psychoemotional state of tested people than in a control group.

Table 1

Effect of *Salvia Sclarea* L. EO, 2,0 mg/m^3, on psychoemotional state of tested people (WAM test parameters, standard units)

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pc b/a<	Pex/c after<
General condition	151,45 ±6,43	150,75 ±6,89	166,75 ±5,03	0,002	156,95 ±5,80	0,08	-
Well-being	148,20 ±7,43	149,95 ±7,08	167,75 ±5,03	0,0007	158,65 ±6,10	0,02	-
Mood	150,80 ±7,12	158,85 ±6,08	171,10 ±5,13	0,005	166,15 ±4,26	0,03	-
Weakness - capacity to work	141,40 ±7,86	145,35 ±7,08	159,20 ±6,38	0,01	146,60 ±6,38	0,88	-
Tension – relaxation	140,55 ±8,45	135,05 ±4,46	161,80 ±6,13	0,01	142,00 ±7,33	0,32	0,05
Inertness –vivacity	140,45 ±7,62	134,75 ±7,08	165,70 ±5,04	0,003	148,00 ±6,29	0,03	0,05
Absent-mindedness – attentiveness	139,60 ±5,49	132,20 ±6,67	152,95 ±5,70	0,02	141,05 ±4,93	0,11	-

According to WAM test initially experimental group having had a dance class in the room concentrated with *Salvia Sclarea* L., 1,0 mg/m^3 and a control group didn`t have any significant differences (table 2).

After class without EO control group demonstrated a rise of general condition, well-being mood, vivacity.

After dance class in the room concentrated with *Salvia Sclarea* L. EO experimental

group actually demonstrated significant improvement of all study parameters like in previous case. But finite values of well-being, mood, capacity to work, vivacity were registered much higher than in the control group, attentiveness tended to rise.

On the whole dance session held in atmosphere concentrated with *Salvia Sclarea* L. EO, 1,0 mg/m^3 resulted much more significant improvement of psychoemotional state of test participants than in case of 2,0 mg/m^3.

Table 2

Effect of *Salvia Sclarea* L. EO, 1,0 mg/m^3, on psychoemotional state of tested people (WAM test parameters, standard units)

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pc b/a<	Pex/c after<
General condition	136,05 ±8,21	137,85 ±7,05	159,15 ±6,05	0,0002	146,25 ±5,26	0,02	-
Well-being	142,00 ±8,35	134,65 ±8,01	165,15 ±5,74	0,0001	145,75 ±6,14	0,03	0,05
Mood	139,65 ±9,46	146,10 ±6,09	170,90 ±5,26	0,0001	155,75 ±3,99	0,01	0,05
Weakness - capacity to work	145,30 ±7,24	134,85 ±7,49	164,10 ±5,92	0,02	140,05 ±6,03	0,23	0,01
Tension – relaxation	128,90 ±8,18	129,55 ±4,37	147,15 ±7,97	0,02	138,45 ±6,99	0,19	-
Inertness –vivacity	128,30 ±8,30	125,95 ±7,65	161,15 ±6,04	0,0002	141,10 ±6,61	0,03	0,05
Absent-mindedness – attentiveness	129,70 ±7,74	127,95 ±7,66	152,15 ±6,25	0,003	136,00 ±5,07	0,20	0,1

Investigating effect of *Salvia Sclarea* L. EO of 0,5 mg/m^3 according to WAM test, initially both groups didn`t have any significant differences like in previous tests (table 3).

Table 3

Effect of *Syzygium Aromaticum* L. EO, 0,5 mg/m^3, on psychoemotional state of tested people (WAM test parameters, standard units)

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pc b/a<
General condition	139,50 ±5,96	132,95 ±6,35	144,90 ±7,51	0,37	146,95 ±5,70	0,01
Well-being	143,25 ±6,54	133,00 ±6,82	145,10 ±8,11	0,77	148,25 ±6,68	0,01
Mood	145,40 ±8,71	148,15 ±5,79	158,10 ±6,14	0,08	159,95 ±4,58	0,001
Weakness –capacity to work	129,15 ±8,82	127,85 ±6,72	135,75 ±9,71	0,48	144,30 ±6,72	0,04
tension – relaxation	130,85 ±7,59	125,45 ±4,64	141,05 ±7,45	0,29	143,05 ±7,36	0,03
Inertness – vivacity	121,20 ±8,87	117,95 ±6,61	130,90 ±9,28	0,35	143,80 ±7,22	0,01
Absent-mindedness – attentiveness	127,45 ±6,91	123,55 ±7,21	128,95 ±7,14	0,85	138,35 ±4,92	0,03

After exercise without essential oil (control group) there was a significant rise of all study parameters of human psychoemotional state.

After dance session with essential oil (experimental group) positive changes were not so pronounced as in control group: mood tended to rise only. But finite values of control and experimental hardly differ.

While studying effect of *Salvia Sclarea* L. EO, 2,0 mg/m^3, on cardiovascular system initially (before procedure) there weren`t any significant differences between values of BP and HR in control and experimental groups (table 4). In this case in both groups average values of BPS and BPD were at high rate by JNC6, HR – higher.

After dance session without EO (control group) values of BPS and HR didn`t change from initial data, BPD tended to increase.

In experimental group just after dance class with *Salvia Sclarea* L. EO BPS reduced much, HR rose and BPD didn`t change. In 15 minutes BPS and BPD were back to initial values and those just after dance class.

In 15 minutes values of BPS, BPD and HR corresponded to initial data. In experimental group in 15 minutes after dance class BPS remained reduced parameters, BPD value became lower than initial, HR got back to mark before procedure.

Table 4

Effect of *Salvia Sclarea* L. EO, 2,0mg/m^3 on blood pressure (mm of mercury) and heart rate (bpm) during exercise

Parameter	Before procedure	After procedure	P <	in 15 min after procedure	before proced. / in 15 min after procedure P<	after procedure. / in 15 min after procedure P<
BPS Experimental group	139,60 4,46	131,55 2,77	0,04	130,40 2,32	0,01	0,59
BPS Control group	135,45 ±4,47	130,60 ±3,70	0,22	130,00 ±3,43	0,21	0,85
BPD Experimental group	87,80 3,06	89,95 1,74	0,30	83,70 2,21	0,02	0,00002
BPD Control group	86,90 ±2,70	89,55 ±2,18	0,10	88,15 ±2,51	0,40	0,29
HR Experimental group	79,90 3,86	93,05 4,45	0,01	84,50 3,42	0,15	0,002
HR Control group	79,75 ±2,99	83,66 ±3,04	0,17	76,05 ±2,24	0,12	0,0001

While studying effect of *Salvia Sclarea* L. EO, 1,0 mg/m^3 on cardiovascular system it was found out that initially BPS, BPD and HR in both groups didn`t have any significant differences (table 5).

After dance session without essential oil (control group) value of BPS didn`t change, BPD increased significantly, HR tended to rise. In 15 minutes after dance class these values got initial marks.

In the experimental group after dance session in the room concentrated with *Salvia Sclarea* L. EO BPD decreased, while BPS tended to slow down, HR didn`t change.

In 15 minutes after dance class in the control group values of BPS, BPD and HR

didn`t differ from initial.

In the experimental group after dances values of BPS and HR were almost on the same mark, but BPD decreased and became lower than before and after procedure.

Table 5

Effect of *Salvia Sclarea* L. EO, 1,0 mg/m^3 on blood pressure (mm of mercury) and heart rate (bpm) during exercise

Parameter	Before procedure	After procedure	P <	In 15 min after procedure	Before proced. / in 15 min after procedure P<	After procedure. / in 15 min after procedure P<
BPS Experimental group	137,85 ±5,02	131,25 ±5,64	0,09	134,55 ±6,32	0,49	0,39
BPS Control group	132,15 ±4,75	133,65 ±4,50	0,60	132,90 ±4,23	0,78	0,81
BPD Experimental group	94,25 ±2,91	89,35 ±3,10	0,03	85,60 ±3,64	0,001	0,08
BPD Control group	87,65 ±3,49	91,40 ±3,11	0,01	89,75 ±3,22	0,18	0,21
HR Experimental group	86,00 ±3,74	91,95 ±4,47	0,12	88,80 ±4,17	0,49	0,40
HR Control group	89,75 ±3,43	98,35 ±1,95	0,06	91,60 ±3,28	0,64	0,002

Investigating effect of *Salvia Sclarea* L. EO, 0,5mg/m^3 on cardiovascular system, initially values of BPS and BPD in both groups were normal by JNC6, but HR was higher. Certain difference of BP and HR values between control and experimental groups wasn`t fixed (table 6).

After dance session without EO (control group) values of BPS and BPD didn`t differ from initial data for certain, but HR had a significant rise.

In experimental group after dance session held in the room concentrated with *Salvia Sclarea* L. EO values of BPS didn`t change, BPD had a tendency, HR rose significantly.

In 15 minutes after dance class BPS and BPD stayed as just after exercise in both groups, HR values reduced till initial marks.

Table 6

Effect of *Salvia Sclarea* L. EO, 0,5 mg/m^3 on blood pressure (mm of mercury) and heart rate (bpm) during exercise

Parameter	Before procedure	After procedure	P <	In 15 min after procedure	Before proced. / in 15 min after procedure P<	After procedure. / in 15 min after procedure P<
1	2	3	4	5	6	7
BPS Experimental group	120,90 ±1,87	120,60 ±1,97	0,87	121,05 ±1,94	0,95	0,76
BPS Control group	126,25 ±3,73	129,10 ±4,50	0,43	126,25 ±3,49	1,00	0,34
BPD Experimental group	82,45 ±1,74	85,15 ±1,56	0,06	83,30 ±2,51	0,71	0,31
BPD Control group	83,25 ±2,54	85,70 ±1,28	0,14	85,45 ±2,05	0,15	0,86
HR Experimental group	85,90 ±3,30	96,70 ±3,15	0,0006	89,30 ±2,45	0,26	0,001
HR Control group	86,85 ±3,18	95,80 ±3,69	0,03	88,00 ±3,31	0,74	0,001

As a result it can be noticed that dances as they are provoke euphoric effect. Extra euphoric effect given by *Salvia Sclarea* L. EO reveals itself in case of the following study concentrations – 1,0 and 2,0 mg/m^3.

Influence of *Salvia Sclarea* L. EO on cardiovascular system is significant in case of higher study concentrations – 1,0 and 2,0 mg/m^3. Hypotensive and tachycardial effects are typical for it.

Therefore optimization of psychophysiological state of tested people determined by their psychoemotional state. Effect of *Salvia Sclarea* L. EO on cardiovascular system is varied.

Conclusions

1. *Salvia Sclarea* L. EO provokes emphasized euphoric effect, that is pronounced during prolonged and medium exercise load in case of the highest study concentration only – 1,0 and 2,0 mg/m^3.
2. *Salvia Sclarea* L. EO possesses hypotensive and tachycardial effects having prolonged medium exercise load in case of the highest study concentrations – 1,0 and 2,0 mg/m^3.

References

1. Osnovy psykhologii: Praktikum / Red. – sost. L.D. Stolyarenko. – Rostov-na-Donu: Pheniks, 2002. – 704 s.
2. Praktikum po psykhologii. / Pod red. A.N. Leontjeva, B. Hyppenreiter. – Izd. Mosk. Un-ta, 1972. – 248 s.

3. *Geun Hee Seol, Yun Hee Lee, Purum Kang, Ji Hye You, Mira Park, Sun Seek Min* Randomized Controlled Trial for *Salvia sclarea* or *Lavandula angustifolia*: Differential Effects on Blood Pressure in Female Patients with Urinary Incontinence Undergoing Urodynamic Examination // J Altern Complement Med. – 2013. 19(7). – July. – P. 664–670.

4. *Peana A.T., Moretti M.D.L*. Pharmacological activities and applications of salvia sclarea and salvia desoleana essential oils // Studies in Natural Products Chemistry. – 2002. - VoI. 26. – P. 391-398

5. *Pitarokili D, Couladis M, Petsikos-Panayotarou N, Tzakou O*. Composition and antifungal activity on soil-borne pathogens of the essential oil of Salvia sclarea from Greece // J Agric Food Chem. – 2002. – 50(23). – Nov 6. – P. 6688-6691.

6. *Seol GH, Shim HS, Kim PJ, Moon HK, Lee KH, Shim I, Suh SH, Min SS*. Antidepressant-like effect of Salvia sclarea is explained by modulation of dopamine activities in rats // Ethnopharmacol. – 2010. – 130(1). – Jul 6. – P. 187-90.

7. *Yang HJ, Kim KY, Kang P, Lee HS, Seol GH*. Effects of Salvia sclarea on chronic immobilization stress induced endothelial dysfunction in rats // BMC Complement Altern Med. – 2014. – Oct 14. – 14:396. doi: 10.1186/1472-6882-14-396.

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Bekmambetov T.R., Tonkovtseva V.V., Litvinchuk N.I., Yarosh A.M. Essential oil of *Salvia Sclarea* L. and its effect on psychophysiological state of people breathing it in different concentration during exercise // Bull. of the State Nikit. Botan. Gard. – 2015. – № 117. – P. 23-29.

Essential oil of *Salvia Sclarea* L. provokes euphoric effect during prolonged medium exercise; on the background of physical activity it is pronounced only in case of the highest study concentrations – 1,0 and 2,0 mg/m^3. Essential oil of *Salvia Sclarea* L. possesses hypotensive and tachycardial effects as well.

Key words: *essential oil, Salvia Sclarea L., eastern dances, exercise load, psychoemotional state, WAM test, human psychophysiological state; nervous system; cardiovascular system.*

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ESSENTIAL OIL OF *HELICHRYSUM ITALICUM* AND ITS EFFECT ON PSYCHOPHYSIOLOGICAL STATE OF ELDERLY PEOPLE BREATHING IT IN LOW CONCENTRATION

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Introduction

Nevertheless essential oils (EO) are used extensively in aromatherapy, there are ones requiring more investigation [6]. Properties of *Helichrysum italicum* (Rhot) Guss. EO concerning central nervous system are to be examined more thoroughly. We held studies of its effect (1 mg/ m^3) on human central nervous system before [5]. It was found out, that *Helichrysum italicum* mainly influences on psychological tone of body: improvement of well-being, rise of vivacity and attentiveness level and tension slowdown. Neuromotor process rate, velocity and accuracy of simple information processing (proof test), short-term memory, mood and anxiety parameters didn`t try any effect of *Helichrysum italicum* EO [5].

The principal point is to minimize load on body in the course of aromatherapy, what is possible if to reduce EO concentration in the atmosphere.

Objective of this research is to study effect of *Helichrysum italicum* EO of 0,1 mg/m^3 on some functions of human central nervous system and cardiovascular system.

Objects and methods of the research

A group of 20 people, mainly women aged by 55-80 years were involved into this study. Control group was a similar group by composition and size. Tested people of the control group were having a rest for 20 minutes listening psychorelaxation record. In experimental group participants in the same room during the same time listening the same psychorelaxation record, but that room was concentrated with *Helichrysum italicum* EO (o,1 mg/m^3). Tests were held before and after procedures.

To define procedures effect on cardiovascular system the following parameters were measured: heart rate (HR), blood pressure systolic (BPS) and blood pressure diastolic (BPD).

While proof test, WAM test and tests that measure thinking rate were used to determine EO effect on nervous system [1, 3, 4].

Findings were processed statistically applying t-criterion by Student [2].

Results and discussion

According to marks of WAM test, initially control and experimental groups didn`t have any significant differences (table 1).

After psychorelaxation session control group didn`t demonstrate any changes of WAM test parameters.

After procedure of aromapsychorelaxation experimental group presented significant reduction of tension, tendency to rise capacity to work, vivacity and attentiveness. On the whole aromasession with *Helichrysum italicum* EO improved psychoemotional state of participants, mainly by tone parameters.

Table 1

Effect of *Helichrysum italicum* on psychoemotional state of tested people (according to WAM test parameters, standard units)

Parameter	Eperimental group initially	Control group initially	Experimental group after procedure	P ex b/a<	Control group after procedure
General condition	165,25±4,69	155,90±7,69	167,35±5,07		163,30±5,55
Well-being	163,00±5,41	160,45±6,57	165,65±5,78		163,40±5,36
Mood	163,20±5,89	158,60±6,23	166,00±5,10		162,95±5,81
weakness –capacity to work	159,70±5,60	151,90±8,03	166,45±5,09	,08	158,25±5,69
Tension – relaxation	143,75±6,26	151,90±6,96	159,805,45	,002	156,15±5,08
Inertness – vivacity	155,90±6,60	153,85±7,47	164,25±5,86	,06	160,85±5,77
Absent-mindedness – attentiveness	142,35±9,66	142,25±8,71	146,70±9,65	,10	149,05±7,38

According to psychoemotional state of tested people by anxiety scale both groups didn`t have any differences (table 2).

After psychorelaxation session in control group there were no any significant changes of test parameters.

After aromapsychorelaxation procedure experimental group didn`t demonstrate any changes of the test parameters as well.

Table 2

Effect of *Helichrysum italicum* on psychoemotional state of tested people (by scale of anxiety and depression, standard units)

Scale	Experimental group initially	Control group initially	Experimental group after procedure	Control group after procedure
Anxiety	6,25±0,94	6,20±0,87	5,80±0,80	5,60±0,98
Depression	6,50±0,90	6,70±0,89	6,45±0,84	6,65±0,85

As a result of procedures effect on mental capacity by proof test (digital data) initial difference between control and experimental groups isn`t significant (table 3).

After psychorelaxation in control group there weren`t any changes.

Procedure of aromarelaxation in experimental group didn`t provoke any changes as well.

Table 3

Effect of *Helichrysum italicum* EO on mental capacity (according to proof test data)

Parameter	Group	Initially	After procedure
Rate 1, sign/min	control	307,30±14,71	324,80±17,13
	experimental	314,60±23,55	335,40±26,74
Mistakes 1, signs	control	2,05±0,69	3,00±0,70
	experimental	1,95±0,36	2,35±0,67
Rate 2, sign/min	control	314,65±18,18	292,30±22,35
	experimental	302,90±31,24	309,40±28,22
Mistakes 2, signs	control	3,20±1,12	3,85±1,03
	experimental	2,15±0,67	1,60±0,37

Initially complex mental processes test (filling the missing letters in words) didn`t get any significant difference between data of control and experimental groups (table 4). As a result of psychorelaxation procedure a number of mistakes tended to rise in a control group. After aromapsychorelaxation there were no any significant changes in the experimental group.

Table 4

Effect of *Helichrysum italicum* EO on thinking rate (data of filling the missed letters test)

Parameter	Group	Initially	After procedure	Pc b/a<
Words, units	control	23,10±1,42	23,10±1,52	
	experimental	26,35±2,21	25,40±2,29	
Mistakes , units	control	1,10±0,28	1,75±0,45	0,08
	experimental	1,30±0,27	1,20±0,27	

Initially before procedures there were no any significant differences between values of BP and HR in control and experimental groups (table 5).

After session of psychorelaxation values of BP and HR in control group didn`t differ from initial data.

In the experimental group session of aromapsychorelaxation provoked reduction of BPS and HR a lot. In this case finite value of BPS in the experimental group was much lower than in control group.

Variations of BPD aren`t significant.

Table 5

Effect of relaxation procedure held with *Helichrysum italicum* EO on BP and HR

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pex/c after<
BPS, mm of Mercury	125,25±4,01	130,80±4,22	116,25±3,21	,001	129,30±4,20	0,02
BPD, mm of Mercury	76,55±1,86	77,75±1,86	74,40±2,32		76,70±2,09	
HR, bpm	72,35±1,67	70,85±1,36	69,35±1,25	,004	70,40±1,38	

Therefore *Helichrysum italicum* EO being in low concentration mainly affected on psychological tone of body: rise of vivacity, attentiveness and capacity to work. Only anxiety reduction was significant.

Much more pronounced effect of *Helichrysum italicum* EO (low concentration) concerned cardiovascular system: significant reduction of BPS and HR values.

Conclusions

1. *Helichrysum italicum* EO increased psychological tone of test participants a little.
2. *Helichrysum italicum* EO almost didn`t affect on mental capacity of test participants.
3. *Helichrysum italicum* EO possesses hypotensive and bradicardial effects.

References

1. *Karvasarsky B.D.* Klinicheskaya psykhologiya. Uchebnik dlya vuzov. CPb.: Izdatelstvo “Piter”, 2004. – 553 s.
2. *Lakin G.F.* Biometriya. – M.: Izd-vo “Vysshaya shkola”, 1989. – 291 s.
3. Osnovy psykhologii: Praktikum / Red.-sost. L.D. Stolyarenko. – Rostov-na-Donu: Feniks, 2002. – 704 s.
4. Praktikum po psykhologii / Pod red. A.N. Leontjeva, B. Hyppenreiter. – Izd. Mosk.un-ta, 1972. – 248 s.
5. *Tonkovtseva V.V., Kulikova Ya.A., Mokin Yu.I., Yarosh A.M.* Vliyaniye efirnogo masla bessmertnika italjanskogo na nervnuyu systemy cheloveka // Aromakorrektsiya psykhophizicheskogo sostoyaniya cheloveka: materialy mezhdunarodnoj nauchno-prakticheskoy konferentsii (Yalta, 4-6 maya 2011 g.) – Yalta, 2011. – S. 64-69.
6. *Babar Ali, Naser Ali Al-Wabel, Saiba Shams, Aftab Ahamad, Shah Alam Khan, Firoz Anwar*http://www.sciencedirect.com/science/article/pii/S2221169115001033 - aff5 Essential oils used in aromatherapy: A systemic review // Asian Pacific Journal of Tropical Biomedicine. – 2015. - Volume 5. – Issue 8. – P. 601–611.

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Tonkovtseva V.V., Koval Ye.S., Bekmambetov T.R., Yarosh A.M. Essential oil of *Helichrysum Italicum* and its effect on psychophysiological state of elderly people breathing it in low concentration // Bull. of the State Nikit. Botan. Gard. – 2015. – № 117. – P. 29 – 33.

Helichrysum Italicum essential oil in concentration 0,1 mg/m^3 and its effect on psychophysiological state of elderly people were investigated in terms of the research. Low concentration of *Helichrysum Italicum* essential oil mainly affected on psychological body tone, as a result - increasing of vivacity, attentiveness and efficiency level,. Its influence in the same concentration occurred more pronounced concerning cardiovascular system: significant reduction of BPS (blood pressure systolic) and HR (heart rate).

Key words: *essential oil, aroma session, Helichrysum Italicum, psychorelaxing record, mental capacity, psychoemotional state.*

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ESSENTIAL OIL OF *LAVÁNDULA ANGUSTIFÓLIA* AND ITS EFFECT ON PSYCHOPHYSIOLOGICAL STATE OF ELDERLY PEOPLE BREATHING IT IN LOW CONCENTRATION

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Introduction

Lavandula angustifolia Mill. essential oils (EO) are used extensively in aromatherapy [6, 9]. It possesses antidepressive and stress-limiting effects [6-9]. It was demonstrated that in case of concentration 1 mg/m^3 *Lavandula angustifolia* EO improves general condition of tested people, reduces personality anxiety, and raises mental capacity [5]. Important task is to minimize load on body in the course of aromatherapy, what is possible if to decrease concentration of that essential oil. It especially concerns elderly people. But in case of lower concentration aromatherapy effect can be not so pronounced.

Objective of this paper is to investigate *Lavandula angustifolia* EO on some functions of central nervous system in low concentration.

Objects and methods of the research

A group of 20 people, mainly women aged by 50-80 years were involved into this study. Control group was a similar group by composition and size. Tested people of the control group were having a rest for 20 minutes listening to psychorelaxation record. In experimental group participants were in the same room during the same time listening to the same psychorelaxation record and breathing *Helichrysum italicum* EO till the finite concentration (0,1 mg/m^3). Tests were held before and after procedures.

To define procedures effect on cardiovascular system the following parameters were measured: heart rate (HR), blood pressure systolic (BPS) and blood pressure diastolic (BPD).

While proof test, WAM test and tests that measure thinking rate were used to determine EO effect on nervous system [1, 3, 4].

Findings were processed statistically applying t-criterion by Student [2].

Results and discussion

According to marks of WAM test, initially control and experimental groups didn`t

have any significant differences (table 1).

After psychorelaxation session control group demonstrated a tendency to reduce capacity to work.

After procedure of aromapsychorelaxation experimental group presented significant improvement of all study parameters, besides vivacity. The latter pointed a tendency to rise. Finite values in experimental and control groups differ a lot – values of all parameters, besides relaxation, experimental marks are higher than control.

On the whole aromasession with *Lavandula angustifolia* EO improved psychoemotional state of participants.

Table 1

Effect of *Lavandula angustifolia* EO on psychoemotional state of tested people (according to WAM test parameters, standard units)

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	P ex b/a<	Control group after procedure	Pc b/a<	Pex/c after<
WAM general condition	128,55 ±7,73	126,40 ±8,02	149,25 ±7,18	0,005	128,00 ±6,92		0,05
Well-being	129,55 ±7,87	127,70 ±8,37	155,65 ±6,46	0,0009	128,65 ±7,08		0,01
Mood	130,95 ±7,64	122,90 ±10,15	160,45 ±6,82	0,0002	125,65 ±8,38		0,01
weakness – capacity to work	130,45 ±8,70	128,20 ±9,23	147,35 ±8,47	0,04	120,50 ±7,64	0,08	0,05
Tension – relaxation	128,15 ±8,09	128,20 ±8,87	149,00 ±8,25	0,01	139,43 ±7,76		
Inertness – vivacity	135,85 ±8,31	126,95 ±10,89	150,40 ±7,26	0,06	126,80 ±6,72		0,05
Absent-mindedness – attentiveness	140,80 ±9,50	138,30 ±7,59	158,85 ±6,42	0,03	132,64 ±6,86		0,05

According to psychoemotional state of tested people by anxiety and depression scale both groups didn`t have any differences (table 2).

After psychorelaxation session in control group there were no any significant changes of test parameters.

After aromapsychorelaxation procedure experimental group didn`t demonstrate any changes of the test parameters as well.

Table 2

Effect of *Lavandula angustifolia* EO on psychoemotional state of tested people (by scale of anxiety and depression, standard units)

Scale	Experimental group initially	Control group initially	Experimental group after procedure	Control group after procedure
Anxiety	6,45±1,05	6,20±0,87	6,20±0,92	5,60±0,98
depression	6,90±0,91	6,70±0,89	6,80±0,83	6,65±0,85

As a result of procedures effect on mental capacity by proof test (digital data) initial difference between control and experimental groups isn`t significant (table 3).

After psychorelaxation in control group there weren`t any changes, only tendency to increase a number of mistakes during the test first minute.

Procedure of aromarelaxation in experimental group provoked significant rise of work rate during the test first minute.

Table 3

Effect of *Lavandula angustifolia* EO on mental capacity (according to proof test data)

Parameter	Group	Initially	After procedure	P b/a<
Rate 1, sign/min	control	288,55±14,84	304,00±14,60	
	experimental	293,00±14,35	325,00±20,36	0,01
Mistakes 1, signs	control	1,40±0,46	2,40±0,62	0,08
	experimental	1,90±0,43	1,95±0,43	
Rate 2, sign/min	control	292,55±16,10	278,70±20,80	
	experimental	284,70±16,92	314,10±24,90	
Mistakes 2, signs	control	2,20±0,76	2.95±0,66	
	experimental	2,75±0,95	1,80±0,55	

Initially complex mental processes test (filling the missed letters in words) didn`t get any significant difference between data of control and experimental groups (table 4).

Procedure of psychorelaxation in control group didn`t provoke any changes.

After aromapsychorelaxation in the experimental group a number of processed words slowed down, what was less than in the control group.

Table 4

Effect of *Lavandula angustifolia* EO on thinking rate (data of filling the missed letters test)

Parameter	Group	Initially	After procedure	P after <	Pex/c after <
A number of words, units	control	23.55±1,31	22,90±1,40		0,1
	experimental	24,20±1,29	19,50±1,34	0,05	
A number of mistakes , units	control	1,25±0,28	1,75±0,45		-
	experimental	1,10±0,18	1,15±0,34		

Initially before procedures there were no any significant differences between values of BP and HR in control and experimental groups (table 5). In this case in both groups average values of BPS were at high rate, BPD was normal by JNC6, HR was normal as well.

After session of psychorelaxation values of BP and HR in control group didn`t differ from initial data.

In the experimental group session of aromapsychorelaxation provoked reduction of BPS till normal points, BPD till maximum mark. BPD tended to lower finite value in the experimental group in comparison with control group.

Table 5

Effect of relaxation procedure held with *Lavandula angustifolia* EO on BP and HR

Parameter	Experimental group initially	Control group initially	Experimental group after procedure	Pex b/a<	Control group after procedure	Pex/c after<
BPS, mm of Mercury	136,00 ±3,86	134,90 ±4,64	124,50 ±4,26	0,003	135,25 ±4,83	-
BPD, mm of Mercury	84,35 ±2,41	83,70 ±2,26	79,10 ±2,08	0,005	85,10 ±2,15	0,1
HR, bpm	70,80 ±2,25	70,35 ±2,50	69,65 ±2,44	-	68,15 ±2,02	-

Therefore *Lavandula angustifolia* EO being in low concentration improved psychoemotional state of tested people, as well as rose efficiency of mental work (proof test). But it actually didn`t affect on more complicated mental work.

As a result principal effects of *Lavandula angustifolia* EO are improvement of psychoemotional state and stimulation of simple mental processes. This essential oil possesses the hypotensive effect what makes possible to put it into practice for work with people suffering from hypertension.

It`s interesting that pointed positive changes appeared in case of low EO concentration – 0,1 mg/m^3.

Conclusions

1. *Lavandula angustifolia* EO improved psychoemotional state of test participants a lot.
2. *Lavandula angustifolia* EO stimulated mental capacity only in case of simple work. More complicated work was inhibited.
3. *Lavandula angustifolia* EO possesses hypotensive effect.

References

1. *Karvasarsky B.D.* Klinicheskaya psykhologiya. Uchebnik dlya vuzov. CPb.: Izdatelstvo “Piter”, 2004. – 553 s.
2. *Lakin G.F.* Biometriya. – M.: Izd-vo “Vysshaya shkola”, 1989. – 291 s.
3. Osnovy psykhologii: Praktikum / Red.-sost. L.D. Stolyarenko. – Rostov-na-Donu: Feniks, 2002. – 704 s.
4. Praktikum po psykhologii / Pod red. A.N. Leontjeva, B. Hyppenreiter. – Izd. Mosk.un-ta, 1972. – 248 s.
5. *Tonkovtseva V.V., Yarosh A.M., Piven I.P., Soiko V.V.* Osobennosti vliyaniya efirnogo masla lavandy na phone psykhorelaksatsii programmy na nervnuyu system cheloveka // Tavrichesky zhurnal psykhiatrii (Acta Psychiatrica, Psychoterapeutica et Ethologica Tavrica) 2009. – Tom 13. – Vyp. 4 (49).
6. *Cavanagh HM, Wilkinson JM* Biological activities of lavender essential oil // Phytother Res. 2002 Jun;16(4):301-308.
7. *Denner SS* Lavandula angustifolia Miller: English lavender // Holist Nurs Pract. 2009 Jan-Feb;23(1):57-64. doi: 10.1097/01.HNP.0000343210.56710.fc.
8. *Effati-Daryani F, Mohammad-Alizadeh-Charandabi S, Mirghafourvand M, Taghizadeh M, Mohammadi A* Effect of Lavender Cream with or without Foot-bath on

Anxiety, Stress and Depression in Pregnancy: a Randomized Placebo-Controlled Trial // J Caring Sci. 2015 Mar 1;4(1):63-73. doi: 10.5681/jcs.2015.007. eCollection 2015.

9. Koulivand P.H., Ghadiri M.K., Gorji A. Lavender and the Nervous System // Evid Based Complement Alternat Med. 2013; 2013: 681304. Published online 2013 Mar 14. doi: 10.1155/2013/681304

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Koval Ye.S., Tonkovtseva V.V., Bekmambetov T.R., Yarosh A.M. Essential oil of *Lavándula Angustifólia* and its effect on psychophysiological state of elderly people breathing it in low concentration // Bull. of the State Nikit. Botan. Gard. – 2015. – № 117. – P. 33 – 37.

Lavándula Angustifólia essential oil (EO) in concentration 0,1 mg/m^3 and its effect on psychophysiological state of elderly people were investigated in terms of the research. Improvement of psychoemotional state and simple mental processes stimulation were the most pronounced results of *Lavándula Angustifólia* EO effect on human higher nervous activity. This essential oil possesses the hypotensive effect what makes possible to put it into practice for work with people suffering from hypertension.

Key words: *essential oil, aroma session, aromatherapy, Lavándula Angustifólia, psychorelaxing record, mental capacity, psychoemotional state.*

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PHYSIOLOGICAL OBJECTIFICATION OF RECREATIONAL MEASUREMENTS. AROMA IMPACT AS A STUDY CASE

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Introduction

Nowadays having definite achievements in the field of medicine and biological researches, including areas of balneology and recreational medicine, scientists debate concept of personalized approach [11, 12], what is capable to improve quality of diagnostics, correction and treatment. Development of this direction is important in the field of natural correctional and therapeutic factors, as standartization of their usage making individual rehabilitational programs needs more attention, while physiological mechanisms hasn`t been investigated enough. All of these require modern diagnostics facilities that make possible to reveal effect on a certain patient, directly in given recreational conditions and develop the optimal correctional program for him. For instance, effect of health path, organized in the zone with blooming flowers is supposed to be different from the one organized in the steppe landscape.

Complex impact of recreational factors combinations is polymodal and provokes synergetic effect, especially in case of aroma influence [8]. Like essential oils (EO), being preformed natural factors, as flower aromas during blooming are multicomponent substances, and their impacts are grounded by complex influences of all substances, but not separate chemical mechanisms. Synergism influence has the following construction: if two or three EO components affecting even in small dosages, but simultaneously, they demonstrate extra activity in comparison with their effects working in consecutive order.

Phenomena of synergism complicates forecast of findings what are results of interaction of some recreational factors and human body combinations with various basic level of adaptive systems work.

In this way objectification of recreational interactions, that mix multidirectional mechanisms affecting on human body, will make it possible to get more efficiency in terms of personalized approach, arrange correctional and medicine measurements.

But diagnostic facilities with a wide range of informative study parameters are possible to approach the field of recreation (for instance forest, park, mountains) with its unique effect (combination of affecting parameters and mechanisms) on human body; the problem lies in inconvenience of equipment and necessary of power source [7].

One of such devices, which solves all these problems is a portable program and technical complex "FAZAGRAF®" [3, 5].

Objective of our research article is to differentiate effects of single impact on human body and various initial parameters of combined effects of aroma influence and physical activity while walking along alleys of Nikita Botanical Gardens in Yalta in the period of rose blooming, what was compared with the same physical activity but in urban landscape.

Objects and methods of the research

A group of 35 conditionally healthy people, 15 of them were 17-years old young men, 10 17-years old girls and 10 women of 37-43 years. Study parameters were fixed sitting during the rest before recreational procedure and during the 5th minute of recreation period after procedure. Conditions for walking in both landscapes (park and urban) were the same: similar temperature and climatic regimes, speed and duration (40 minutes).

Registration and analysis of ECG in a phase space were organized applying program and technical complex "FAZAGRAF®", which works due to original informative technology of processing the electric cardiosignal in phase space also including concepts of cognitive computer graphics and methods of automatic recognition of images (fig.1). Ring electrodes of the complex make it possible to registrate signal quickly and don`t complicate testing in recreational conditions.

Fig.1 Registration of single-channel ECG under conditions of recreational measurement applying ring electrodes PTC "FAZAGRAF®"

The following parameters were analyzed: HR (bpm), T-wave symmetry (β_T, units), standard deviation β_T (SD β_T, ms), mode range (AMo,%), vagosympathetic balance factor (LF/HF).

Statistic research results processing was conducted applying software package STATISTICA 6.0 (StatSoft, Inc., USA). Goodness-of-fit test by Kolmagorov-Smirnov were

used to assess divergence of factors distributions. Authenticity of differences between like factors in independent samples was estimated due to nonparametric U-criterion Mann-Witney. Authenticity of differences between like parameters of tested people before and after recreational procedures was defined by nonparametric T-criterion Wilcoxon. In case of standard distribution parametric t-criterion by Student was applied.

Results and discussion

It`s a well-known fact that any deviation from optimal functioning of any system including physiological is a result of control and regulatory mechanisms deformation, what reduces efficiency of physical and mental activity.

As a result of this research extra sensory factors like blooming rose flavor in terms of recreational procedure had various effect on functional state of tested people. In this way physical load that is walk combined with aroma effect had the most productive result in group of girls and women (table 1).

Table 1

Change of cardiohaemodynamics and variability of HR parameters before and after recreational procedure held in Botanical Garden, (M±m, n=35)

C	Condition parameters									
	HR, bpm		β_T, units		CKO β_T, ms		AMo, %		LF/HF, units	
	before	after	before	after	before	after	before	after	before	after
Y	74,4 ±2,6	68,2 ±3,1	0,65 ±0,05	0,65 ±0,02	0,063 ±0,007	0,046 ±0,003**	34,8 ±2,6	30,4 ±2,9	2,86 ±0,53	1,68 ±0,28**
G	72,3 ±4,5	60,55 ±0,9**	0,67 ±0,05	0,60 ±0,02	0,106 ±0,044	0,088 ±0,037	31,4 ±2,1	24,3 ±2,2**	2,27 ±0,42	0,44 ±0,18***
W	78,1 ±3,4	75,7 ±3,4	0,83 ±0,03	0,74 ±0,01**	0,091 ±0,013	0,054 ±0,008**	50,1 ±2,04	39,9 ±4,1*	2,1 ±0,70	2,1 ±0,38

Notes: C-contingent; Y-youth, young men of 17 years old (n=15); G-girls of 17 years (n=10); W-women of 37-40 years old (n=10); authenticity before and after recreational procedure on the level * - $p < 0,05$; ** - $p < 0,01$; *** - $p < 0,001$

Centralization of HR control by AMo in girls and women groups became 20% less ($p < 0,01$; $p < 0,05$), on the background of stable parameter of vagosympathetic balance of women and increasing of parasympathetic effect of girls – more than 5 times ($p < 0,001$). It`s well-known that natural flavors, being a component of oil-bearing plants are capable to optimize HR, an indicator of not only heart state, but mechanisms of its central and autonomous control, what is changeable in case of physical and psychoemotional load [1, 2, 9, 10]. Nowadays variability of HR as an integral mark of control mechanisms, providing homeostasis, is paid much attention. There is an opinion that unnecessary periodicity and disorder in system functioning, including HR control, could be predict development of various heart pathologies or forecast aggravation of human state. That`s why record of individual reactions to recreational procedures during sanatoria and health period of treatment and rehabilitation gains a great importance for optimization of recovery, especially for patients with cardio pathology.

Planning health resort treatment including aromatherapy age factor should be considered. In our research in spite of unidirectional increasing of variability of heart rate and trophotropic effect of parasympathetic division of nervous system, women and girls had different cardiohemodynamic modifications. According to table 1, after single recreational procedure after 40-minute walk during recreational period HR of girls 27,3% reduced ($p <$

0,01). Women having steady HR values before and after procedure, myocardium function improved according to parameters of T-wave symmetry, which 10,0% reduced ($p < 0,01$). Metabolic processes while providing myocardium with oxygen form functional myocardium reserve to be able to realize mechanical heartbeats in case of extra load, for example physical activity. Big role in this process goes to repolarization of ventricles, as its disorder can cause electrical inhomogeneity of myocardium and worsening of contractile force, strain of functional state and reduction of adaptive abilities. It is known that a shape of T-wave depends upon duration and value of transmembrane action potential along different myocardium zones [4].

Increasing of myocardium reserve of women was proved by reduction of CKO β_T - 40,3% on average ($p < 0,01$). Perhaps activity of humoral control in a body of mature women takes part in control processes of microvasculature better than in immature organism of girls.

Gender peculiarities of reaction to olfactive stimulation revealed before were proved in this research. In spite of that reaction, homotype with girls, of activity increasing of parasympathetic division of vegetative control, effect on young men for 42,3% ($p < 0,01$) became apparent by reduction of variability β_T - 27,0% ($p < 0,01$).

To differentiate effects of aroma treating and walk, scientists organized conditions of the same physical load but in urban landscape without extra sensory influence. According to table 2 and figure 2, authoricity of differences after recreational procedures in urban conditions and botanical garden, confirm importance of natural aromatic stimuli and minimizes physical load effect as it is.

Table 2

Change of cardiohaemodynamics and variability of HR parameters before and after walk held in the city conditions, (M±m, n=35)

C	Condition parameters									
	HR, bpm		β_T, units		CKO β_T,ms		AMo, %		LF/HF, units	
	before	after	before	after	before	after	before	after	before	after
Y	71,3 ±2,3	73,4 ±3,0	0,662 ±0,017	0,671 ±0,025	0,061 ±0,005	***0,058 ±0,004 ****	32,6 ±2,4	33,6 ±1,6	2,77 ±0,65	***2,47 ±0,27****
G	80,2± 3,9	***76,2*± *3,7******	0,707± 0,048	***0,780*± *0,031****	0,091± 0,042	0,093± 0,017	31,3± 3,5	***31,3*± *2,1****	2,03± 0,26	***3,04*± *0,79******
W	77,2± 3,0	***85,7*± *1,4****	0,810± 0,029	***0,843*± *0,01******	0,090± 0,023	***0,089*± *0,013****	49,1± 2,04	***69,2*± *5,1******	2,0± 0,78	***2,9*± *0,19****

Notes: C-contingent; Y-young men of 17 years old (n=15); G-girls of 17 years old (n-10); W-women of 37-40 years old (n=10); *italicized data* – authenticity of differences after recreational procedure in Botanical garden in comparison with the same procedure in the city conditions on the level * - $p < 0,05$; ** - $p < 0,01$; *** - $p < 0,001$

It`s also important to note that in women group parameter LF/HF after graduated walk under the city conditions became 45,0% more ($p < 0,01$), but having the same activity in botanical garden it remained stable.

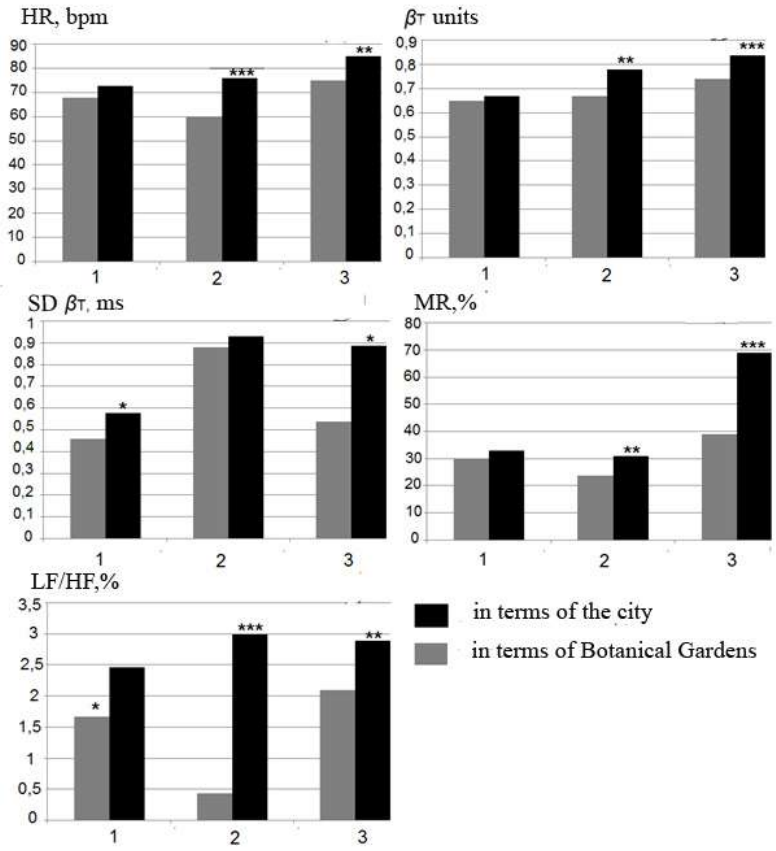

Fig.1 Comparative characteristics of parameters variations of cardiohaemodynamics and variability of heart rate after recreational procedure held in Botanical garden and urban landscape

Notes: 1 – young men of 17 years old (n=15); 2 – girls of 17 years old (n=10); women of 37-40 years old (n=10); authenticity of parameters differences after recreational procedure in urban landscape in comparison with parameters fixed after recreational procedure in Botanical garden * - $p < 0,05$; ** - $p < 0,01$; *** - $p < 0,001$; A – HR (bpm), B – T-wave symmetry (β_T , units), C – standard deviation β_T (SD β_T), D – mode range (MR, %), E – coefficient of vagosympathetic balance (LF/HF).

Therefore aroma influence including liminal and subliminal concentrations, under natural conditions of park zone, activating mechanisms of adaptation and homeostasis, had a systematic effect on organism, optimized cardiovascular system, favored renewal of vegetative control balance of HR what increases stress resistance of patients and reduces aftereffects of physical load.

Conclusions

1. Centralization of HR control according to AMo parameter in groups of women and girls became 20,0% less ($p < 0,01$; $p < 0,05$), on the background of stable parameter of vagosympathatical balance of women and increasing parasympathetical effect of girls – 5 times more ($p < 0,001$).

2. In the group of girls after single recreational procedure after 40-minute walk during recreational period reduction of HR value was registrated – 27,3% less ($p < 0,01$). As to women, having stable before and after procedure HR there was improvement of myocardium function according to T-wave symmetry, what became 10,0% less ($p < 0,01$) and reduction of SD β_T - 40,3% on average ($p < 0,01$).

3. LF/HF of young men became 42,3% less ($p < 0,01$), what caused reduction of variability βT – 27,0% less ($p < 0,01$).

4. Authenticity of differences after recreational procedures in botanical garden and city confirms importance of natural aromatic stimuli and minimizes independent effect of physical load; partitive and autonomous PTC "FAZAGRAPH®" makes it possible to registrate informative parameters of SSS in case of physiological objectification of recreational factors effects on human body.

References

1. *Bykov A.T., Malyarenko T.N.* Sensorny pritok i optimizatsiya funktsy serdtsa i mozga. – Rostov-na-DOnu, 2003. – 498 s.

2. *Govsha Yu.A.* Zavisimost regulyatsii serdechnogo ritma ot sensornyh pritokov raznoy modalnosti u cheloveka. – Kursk, 2003. – 18 s.

3. *Grytsenko V.I.* Informatsionnaya tekhnologiya FAZAGRAPH® dlya integralnoy otsenki sostoyaniya serdechno-sosudistoy sistemy po fazovomu portretu elektrokardiogrammy. – M.: Izd-vo "Vysshaya shkola", 1989. – 291 s.

4. *Minina Ye.N.* Analiz volny T EKG v fazovom prostranstve v opredelenii funktsionalnyh rezervov miokarda // Ucheniye zapiski Tavricheskogo natsionalnogo universiteta imeni V.I. Vernadskogo. – 2013. – 26(65), № 2:148. – S. 153.

5. *Fainzilberg L.S.* Kompjuternaya diagnostika po fazovomu portretu elektrokardiogrammy. – K.: Osvita Ukrainy, 2013. – 190 s.

6. *Chervyakov A.V., Fokin V.F.* Dinamika funktsionalnoy mezhpolusharnoy assimetrii pod vliyaniyem zapakha lavandy // Assimetriya. – 2008. – T.2. - №2. – S.32-40.

7. Ambulatory cardiac monitoring: Avoiding maturity through technological advancement. – Market engineering research. – Frost & Sullivan, Meriland. – 2008. – 9. – P. 325.

8. *Buckle J.* Clinical Aromatherapy. 2nd ed. - London: Elsevier Limited, 2004. – 416 p.

9. *Saeki Y.* The effect of foot-bath with or without the essential oil of lavender on the autonomic nervous system: a randomized trial // Complement. Therap. Med. – 2000. – Vol. 8, N 1. – P. 2-7.

10. *Saeki Y., Shiohara M.* Physiological effects of inhaling fragrances // Intern. J. of Aromatherapy. – 2001. – Vol. 11, N3. – P. 118-125.

11. *Tezak Z., Kondratovich M.V., Mansfield E.* US FDA and personalized medicine: in vitrodiagnostic regulatory perspective. Journal of Personalized Medicine. – 2010. – No. 7(5). – P. 517–530.

12. *Wolbring G., Leopatra. V.* Sensors: Views of Staff of a Disability Service Organization. Journal of Personalized Medicine. – 2013. – No. 3. – P. 23–39.

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Minina Ye.N., Tonkovtseva V.V., Phynogentov P.V. Physiological objectification of recreational measurements. Aroma impact as a study case // Bull. of the State Nikit. Botan. Gard. – 2015. – № 117. – P. 37-42.

In terms of the research effect of a single aroma impact and exercise on human body with different initial parameters was analyzed for the first time. The combined effect was registered during walks along Nikita Botanical Gardens (Yalta) paths while rose blooming what was compared with the same physical activity but within urban landscape. Importance of natural aroma stimuli is underlined in the article, portable and autonomous PTC "FAZAGRAF®" fixes informational parameters of cardiovascular system within physiological objectification of recreational factors effect on human body.

Key words: *aroma impact, variability of the heart rate, symmetry of T-wave, PTC "FAZAGRAF®", recreation.*

ESSENTIAL OIL-BEARING AND MEDICINAL PLANTS

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PERSPECTIVE SOURCES OF ESSENTIAL OILS FOR MEDICINE AND PERFUME-COSMETICS

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Introduction

Recent decades people demonstrate a heightened interest to essential oils used as medioprophylactic remedies [2]. Such scientific branches as aromatherapy and aromacorrection of the human psychophysical state require not only natural oils of principal essential oil-bearing cultures, like Lavender [5], but oils of rare hardy aromatic plants as well.

Satureja hortensis makes it possible to increase raw material base of essential oil-bearing plants, used for production of expectorant and antimicrobial medicine to treat bronchopulmonary pathology [8]. Guidance of aromatherapy emphasizes anesthetic, antiseptic and wound healing effect of *Satureja hortensis* essential oil [2]. Typical for this oil burning taste and specific flavor confirms carvacrol content in there. Aqueous-alcoholic extraction of *Satureja hortensis* from the grass inhibits *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginoza* growth [8]. *Calamintha nepeta* is widespread in many countries as diuretic, gastric and enhancing potency medicine.

The objective of this research is to mark out highly-productive forms, potential sources of essential oil and raw material to comply demands of domestic medicine and perfume-cosmetic industry.

Objects and methods of the research

Selective patterns of *Lavandula angustifolia* L., *Calamintha nepeta* (L.) Savi and *Satureja hortensis* L. were being instigated in 2008-2011 at experimental base of SBE RC RIAC of the Crimea, situated within piedmont zone of the Crimea (vil. Krymskaya Roza in Belogorsky region). This location belongs to the IV agroclimatic district, that is upper piedmont, warm, not humid enough climate, goes to northern subdistrict with moderate mild winter [6]. Soils are piedmont carbonate chernozems on eluvium and deluvium of carbonate rocks. Experimental zone is characterized by moderately continental climate: + 10°C period lasts 5,5-6 months, average annual air temperature is 9,8°C according to data of weather station in Belogorsk. Average annual amount of precipitations makes 450-500 mm. Hydrothermal index is 0,92 on average what confirms moderately arid character of agroclimatical conditions during vegetation [4].

Records and observations were carried out according to notes "Selection of essential oil-bearing cultures" [7]. Mass fraction of essential oil in flower-herbaceous material was done being guided by methodological recommendations "Biochemical methods for analysis of essential oil- bearing plants and essential oils" [1]. Component composition of essential oil

was determined applying chromatograph Agilent Technologies 6890 mass-spectrometer sensor 5973. chromatographic column – capillary HP-5 (30 m long); inside diameter – 0,32 m. Carrier gas is helium, stream velocity – 1,5 ml/m. Temperature of input trial heater is 250°C. Thermostat temperature is set in range from 50 till 320 °C with velocity of 4°C per minute. Mathematical data treatment is carried out according to "Method of the field experience" by B.A. Dospekhov [3].

Results and discussion

Fifteen selective clones of *C.nepeta* were investigated and as a result it was found out that essential oil content in the raw material ranged from 0,417 till 0,625%, in the bonedry material – 0,822-1,568%; crop capacity – 236-555 g/plant; essential oil yield – 1,3 – 2,9g/plant. As to crop capacity of verdurous masses average sum total with 95% probability ranged 308÷432g/plant, while essential oil content in the raw material was 0,520÷0,580%, in the bonedry material – 1,186÷1,418 (table 1).

5 clones (№№ 3-а, 4-II, 3-в, 68, 3-б) with crop capacity of raw material ranged from 447-555g/plant were marked in terms of this research. These indices were found 3,4-28,5% more than average total sum. At the same time 4 clones (№№ 38-5, 11-5, 68, 11) with mass fraction of essential oil in the raw material ranged from 0,588-0,625% were marked out, as their parameters occurred 1,4-7,8% more than average total sum. As to essential oil yield 3 clones (№№ 3-в, 68, 3-б) significantly exceeded average total sum (2,0±0,3 g/plant) – 17,4-26,1% more. A complex of economically valuable characters clone №68 (see table 1) was emphasized as its raw material and essential oil are capable to increase raw material base for production of domestic medicines and cosmetic products.

Table 1

Crop capacity characteristics of *Calammtha nepeta*, 2008-2011

Clone	Crop capacity of verdurous masses, g/plant	Mass fraction of essential oil in the raw material, %		Essential oil yield, g/plant
		raw	Bonedry	
1	2	3	4	5
67-st	281	0,417	0,822	1,3
3-a	502	0,479	1,023	2,3
4-II	447	0,533	1,208	2,3
65	383	0,550	1,222	2,1
11-1	239	0,550	1,276	1,3
3-в	555	0,517	1,404	2,7
4	412	0,567	1,459	2,3
38-5	256	0,621	1,568	1,6
66	424	0,538	1,318	2,3
11-5	236	0,600	1,477	1,4
11-2	296	0,571	1,412	1,7
68	491	0,588	1,484	2,9
3-б	494	0,550	1,120	2,7
38	296	0,550	1,180	1,7
11	245	0,625	1,558	1,5
$\bar{x}\pm t_{05}S_{\bar{x}}$	370±62 (308÷432)	0,550±0,030 (0,520÷0,580)	1,302±0,116 (1,186÷1,418)	2,0±0,3 (1,7÷2,3)

Rate of *Lavandula officinalis* hybrids gave an opportunity to get economically valuable forms necessary for industry. Crop capacity of study clones was in terms of standard values. Mass fraction of essential oil of all study samples significantly exceeded values of Stepnaya cultivar. As to essential oil yield clone № 417-3 was 47% more than a control sample, while others had an advantage at this parameter (table 2). Bush shape character of all

clones significantly exceeded standard and were rated as 7-9 points. Sample № 417-3 (9 points) was found as the most winter resistant, № 372-1 (47,29%) was marked out as a clone with the highest content of linalyl acetate. Clone № 417-3 was a leader according to economically valuable characters.

Table 2

Characteristics of *Lavandula officinalis* selective samples, 2008-2010

Sample №	Inflorescence productivity, g/bush	Mass fraction of essential oil in raw inflorescences, %	Essential oil yield		Linalyl acetate content in essential oil, %	Autumn regrowth, point	Bush shape, point	Winter resistance, point
			g/bush	± standard				
Steppe-st	228	1,310	2,96	0	34,14	9	5	7
410-1	201	2,010	3,95	+33	30,00	7	9	7
393-19	199	1,970	3,88	+31	35,13	7	7	7
417-3	221	2,050	4,34	+47	37,62	7	7	9
372-1	199	1,930	3,79	+28	47,29	7	7	7
HCP_{05}	64,5	0,270	1,36					

In terms of this research 34 essential oil components of *S. Hortensis* selective sample were marked out while studying its qualitative composition (fig., table 3), main of them are: carvacrol (42,7%), γ-terpinene (26,5%), α-terpinene (6,9%), p-cymene (6,9%). Content of these components makes it possible to recommend essential oil of this sample for production of phytopreparations with expectorant, wound healing, bactericidal and fungicidal effects.

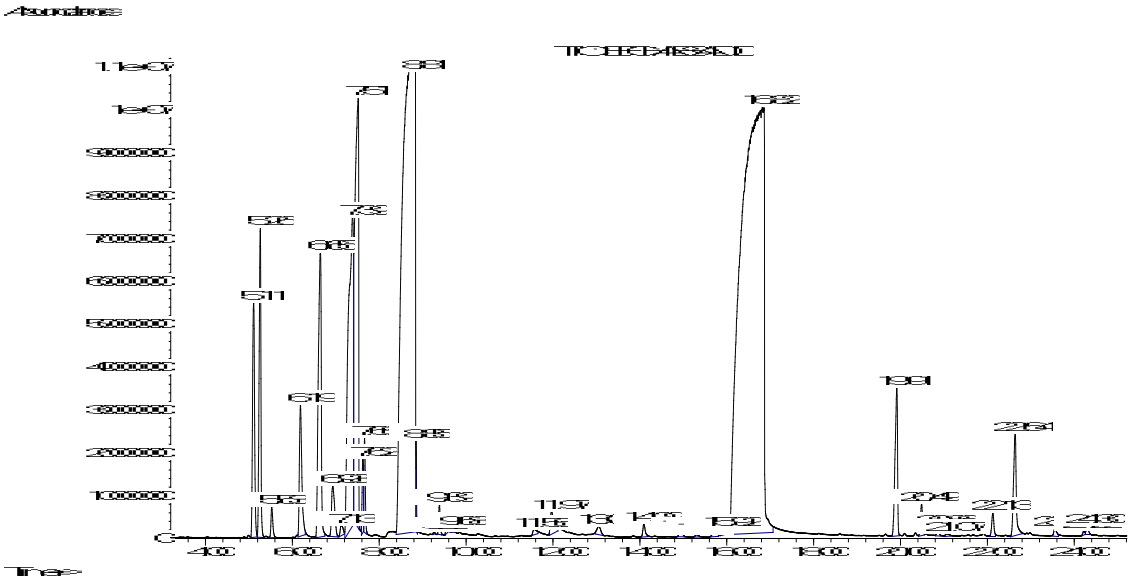

Fig. Chromatogram of *Satureja hortensis* essential oil

Table 3

Component composition of *Satureja hortensis* essential oil

№	Emergence time, min	Identified components	Mass fraction, %
1	2	3	4
1	5.106	α-tuyen	2,119
2	5.264	α-pinene	2,432
3	5.526	camphene	0,252

4	6.189	β-pinene	1,406
5	6.649	β-myrcene	3,697
6	6.933	α-phellandrene	0,691
7	7.127	carene	0,126
8	7.388	α-terpinene	6,922
9	7.515	p-cymene	6,874
10	7.623	β-phellandrene	0,464
11	7.663	limonene	0,523
12	8.814	γ-terpinene	26,466
13	8.850	trans-sabinene hydrate	0,181
14	9.265	1-methyl-4-(1-methylethyl) benzoate	0,014
15	9.386	α-terpinolele	0,209
16	9.544	cys-sabinenehydrate	0,051
17	9.684	linalool	0,036
18	11.565	corneol	0,086
19	11.971	cerpen-4-ol	0,415
20	14.091	carvacrol methyl ether	0,139
21	14.938	cyclohex-2-en-1-on	0,075
22	15.304	p-ment1(7)-en-2-on	0,032
23	15.705	m-thymol	0,098
24	15.917	p-thymol	0,150
25	16.824	carvacrol	42,690
26	19.913	β-caryophyllene	1,611
27	20.486	aromadendrene	0,284
28	20.860	α-humulene	0,086
29	21.068	allo-aromadendrene	0,043
30	22.128	lyeden	0,230
31	22.637	β-bisabolene	1,235
32	23.553	α- bisabolene	0,100
33	24.221	spathulenol	0,037
34	24.297	Caryophyllenoxide	0,085

Conclusions

As a result of this investigation there are promising sources of essential oil marked out for medicine, perfume and cosmetic industry. At the same time clone of *Calamintha nepeta* (crop capacity of 491 g/plant and mass fraction in the raw material 0,588%) and sample of *Satureja hortensis* (contains in essential oil 42,7% of carvacrol and 26,5% of γ-terpinene) are both appreciated in special cosmetics and pharmaceutical industry. Clone of *Lavandula officinalis* with hybrid origin - № 417-3 - with inflorescence crop capacity of 221 g/bush, mass fraction of essential oil 2,050% and linalyl acetate concentration 37,62%, essential oil yield 4,34 g/plant is promising material for high perfume industry.

References

1. Biokhimicheskiye metody analiza efiromaslichnyh rasteny i efirnyh masel. – Simferopol, 1972. – 107 s.

2. *Voitkevich S.A.* Efirniye masla dlya parfumerii i aromaterapii. – M.: Pishchevaya promyshlennost, 1999. – S. 259.

3. *Dospekhov B.A.* Metodika polevogo opyta (s osnovami statisticheskoy obrabotki rezultatov issledovany). – M.: Agropromizdat, 1985. – 351 s.

4. Metodicheskiye rekomendatsii po analizu pogodno-klimaticheskih uslovy i rezultatov vyrashchivaniya selskokhozyaistvennyh kultur. – Simferopol, 2008. – 55 s.

5. *Nazarenko L.G., Afonin A.V.* Efironosy yuga Ukrainy. – Simferopol: Tavriya, 2008. – S.34.

6. *Savchuk L.P.* Klimat predgorya Kryma i efironosy. – Simferopol, 2006. – 76 s.

7. Selektsiya efiromaslichnyh kultur (metodicheskiye ukazaniya) / Pod red. d-ra s-h.nauk, prof. A.I. Arinshtein. – Simferopol, 1977. – 150 s.

8. *Tanskaya Yu.V.* Farmakognosticheskoye izucheniye chabera sadovogo (*Satureja hortensis* L.), introdutsirovannogo v Stavropolskom kraye: Avtoref.diss…kand.farm.nauk: 15.00.02 / Pyatigorskaya gosudarstvennaya farmatsevticheskaya akademiya Federalnogo agenstva po zdravoohraneniyu i sotsialnomu razvitiyu. – Pyatigorsk, 2009. – 27 s.

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Platonova T.V., Merkuryev A.P., Ametova E.D., Skyba A.V., Merkusheva M.B., Babanov N.S. Perspective sources of essential oils for medicine and perfume-cosmetic industry // Bull. of the State Nikit. Botan. Gard. – 2015. – № 117. – P. 43 – 47.

Selective patterns of *Calammtha nepeta, Lavándula angustifólia* and *Satureja hortensis* were investigated to breed high-productive forms. The article presents data of essential oil and linalyl acetate content, crop capacity, winter resistance of lavender clones. There are also characteristics of *Calammtha nepeta* clones according to economic attributes and *Satureja hortensis* by component composition of its essential oil. Perspective sources of essential oils for medicine and perfume-cosmetic industry were marked out as well.

Key words: *Calammtha nepeta, Lavándula angustifólia, Satureja hortensis, essential oil.*

REPRODUCTIVE BIOLOGY OF PLANTS

UDK 582.471:581.321.1(477.75)

REPRODUCTIVE STRUCTURES FORMATION IN *TORREYA GRANDIS* FORTUNE EX LINDL. UNDER THE CONDITIONS OF SOUTH COAST OF THE CRIMEA

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Introduction

One of the most important issues of botanical gardens is to extend species and form assortment of plants, used in ornamental gardening. Recent decades plants that possess not only ornamental characteristics but food and medicinal value are especially investigated.

Coniferous plants are widespread in the field of ornamental gardening due to their evergreen needles keeping all year round, prolonged life-span, diversity of forms and phytoncides that have health giving qualities. Moreover seeds of some coniferous cultivars as follows possess high nutritive value: among well-known pines (*Pinus sibirica* Du Tour, *Pinus koraiensis* Siebold & Zucc., *Pinus pumila* Regel, *Pinus mugo* Turra, *Pinus pinea* L., *Pinus coulteri* D.Don and etc.) there is *Torreya grandis* Fortune ex Lindl. (family Taxaceae) as well, which inhibits in eastern regions of China and is cultivated in Europe and America as an ornamental plant. In China *Torreya* is an important industrial culture as its seeds besides high nutrition value and interesting taste contain vitamins, mineral elements, proteins and indispensable fatty acids. In addition different plant parts have antihelminthic, anti-inflammatory, antifungal and antibacterial effects as well as antitumoral action [6]. Biochemical analysis of *Torreya* oil extracted out of seeds revealed that it includes 18 components and principal are: linoleic (42,02%) and oleic (32,14%) acids. In the course of *Torreya* study it was found out this oil possesses antioxidant activity and capacity to output

free radicals [7].

There are just some *T. grandis* plants in Arboretum of Nikita Botanical Gardens. According to data of long-term visual investigations plants are not frosted over even during the most severe winters, air-drought-resistant, but soil-humidity-requiring and in need irrigation during dry season [2]. Therefore this cultivar is possible to grow on South Coast of the Crimea as an ornamental plant. But there is a condition: planting material grown out of seeds which had been formed during introduction is a necessary point. At the same time seed formation of gymnosperms is quite complex and prolonged process that consists of a number of stages. Study of gymnosperm and angiosperm plants showed that embryological process terms are conditioned not only by organism properties, but controlled by environmental factors. In this way investigation of plants sexual reproduction under conditions of introduction makes it possible to solve practical task (obtaining of full-grown viable seeds) from one hand, from another hand it extends knowledge about cultivars adaptive capacity.

Objective of this work is to find out characteristics of female reproductive structures formation of *Torreya grandis* Fortune ex Lindl. (family Taxaceae) being cultivated on South Coast of the Crimea.

Objects and methods of the research

Torreya grandis Fortune ex Lindl. growing in nature is diecious tree of 25 m high and 0,5 (till 2 m) across diameter with yellow and gray, gray or gray and brown bark. Leaves are linear and lanceolate, as a rule straight 1,1-2,5 (till 4,5) sm long and 2-3,5m wide. It grows in the mountains, on the open valleys, often along river banks, on yellow, brown and dark soils 200-1400 m above the sea level in some regions of East China.

NBG collection possesses some representatives of *T. grandis:* one female and four male specimens. Female plant is a tree of 4 m high, 14 sm across diameter, while male trees are 2,5-4 m high, 3,5-6 sm across diameter. Leaves – (0,6) 0,8 – 1,6 (till 2,2) sm long and 1-,38 mm wide.

Climatic characteristics of T. grandis inhibits.

Natural areal of *T. grandis* is in the zone of monsoonal subtropical climate with hot and humid summer (average temperature in July is 27°C above zero or higher) and relatively fresh and dry winter (average temperature of January is +1-3°C). Annual amount of precipitation makes 1000 mm, registered mainly from May till October.

Climatic characteristics of introduction region. Climate of South Coast of the Crimea is characterized by average annual temperature +12,4°C that ranges in some years from +10,8°C till 14,0°C. Average temperature of the coldest months (January, February) makes +3,1°C, warmest (July, August) is 23,2-23,0°C above zero. Frost-free season lasts 178-309 days. Annual average amount of precipitations makes 621 mm, that mainly fall during cold period (September-March) with maximum in December, January [4].

Methods of the research

Phenological observations and collection for cytoembryological investigations were carried out at intervals of 7-10 days. Material was fixed in Karnua solution (6:3:1), permanent preparations were made according to agreed in cytoembryology method [3] and imbued with methylic green and pyronin tincturing with alcyanic blue [5].

Results and discussion

Single ovules that are formed in vegetative and generative buds, in axils of needles in basic and central parts of germinal shoots represent female reproductive structures of *T. grandis.* As a rule one needle axil contains a couple of ovules (sometimes single ovules emerge in basal parts of shoots, but on shoot tops there can be three ovules). Visually buds with generative structures differ from vegetative buds in late period of development, under

conditions of South Coast of the Crimea, in the end of February – beginning of March.

During the second decade of March in axils of primordial needles in the basal shoot part rudiments of bracts were noticed, space between them was filled with meristematic knob that gives rise to a couple of ovules that grow on the same base.

Knobs consist of meristematic cells – differentiate epidermis – regular square shaped-cells with thicker capsules than others.

On South Coast of the Crimea by the first decade of April ovule collections have been developed completely. Developed ovule collection is situated in the axil of a modified leaf (they are much shorter than leaves on vegetative shoots). It is a couple of ovules, situated in axils of bracts. The latter are green with thin scarious edges and grow in lateral way concerning shoot axis. Ovules grow on the same base being occupied by 2 couples of opposite green scales (fig.1).

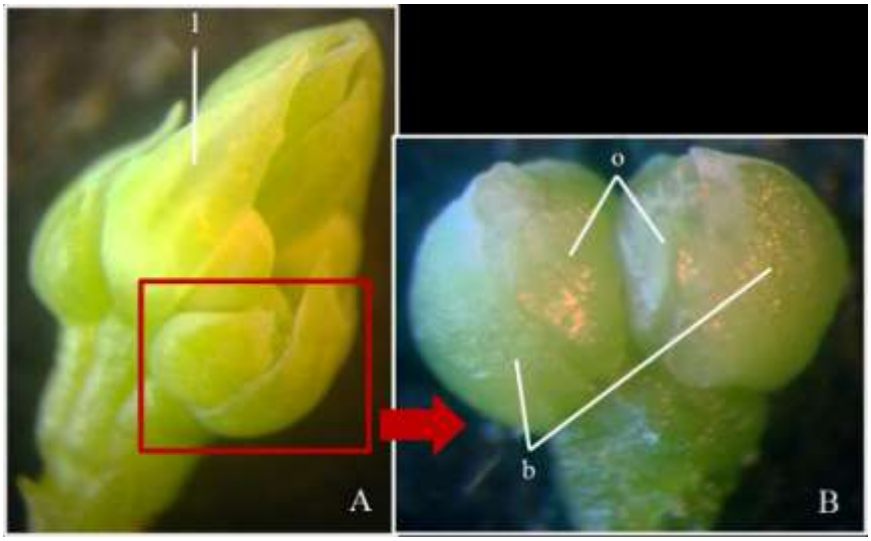

Fig.1 Megastrobil collections of Torreya grandis
A – megastrobil collections on vegetative and generative shoot, B – a couple of megstrobils in bracts axils, b – bract, l – leaf, o - ovule

Ovules are closed completely with scales and consist of some nucellus that is on the active stage of growing, and well-developed integument. Integument top forms micropylar channel that has two small lobes. In the second decade of April shoots bearing ovule collections starts lenthen, but ovules are completely closed with adjoining scales. As a result of experiment, ovules on the branch being in the room of 20-22°C above zero, opened and on the micropyl a pollination drop emerged. On SCC pollination of *T. grandis* takes place since the second decade of April till the second decade of May depending upon weather conditions. In natural areal pollen grains flying happens a little bit earlies – in April [9]. By pollination micropyle of ovules lengthens and overtops the scales. Micropyle top of ovules becomes level and pollinated dew emerges (fig.2).

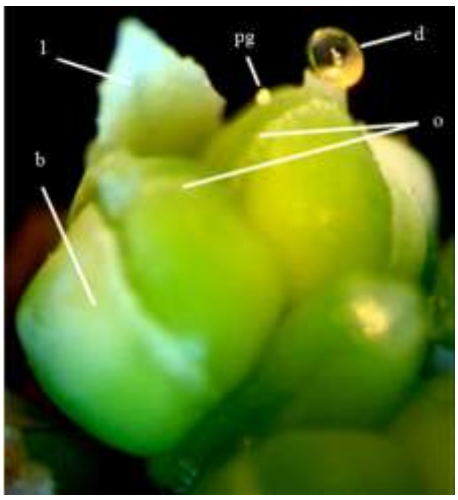

Fig.2 Ovule *Torreya grandis* during pollination, b – bract, d – pollinated drop, l – leaf, pg pollinated grain, o – ovule

Cells of nucellus contain a lot of small amyloid grains and have an active process of fission. Nucellus is well-developed, in the centre of apical zone cells have thickened rounded form, and blind pits emerge between them. Cells content of top 2-3 rows degenerates, the rest of core and cytoplasm get a cell wall making pollen chamber. Under these cells there are rounded cells with rather dense cytoplasm and cores that have lumps of chromatin and a number of nucleoli.

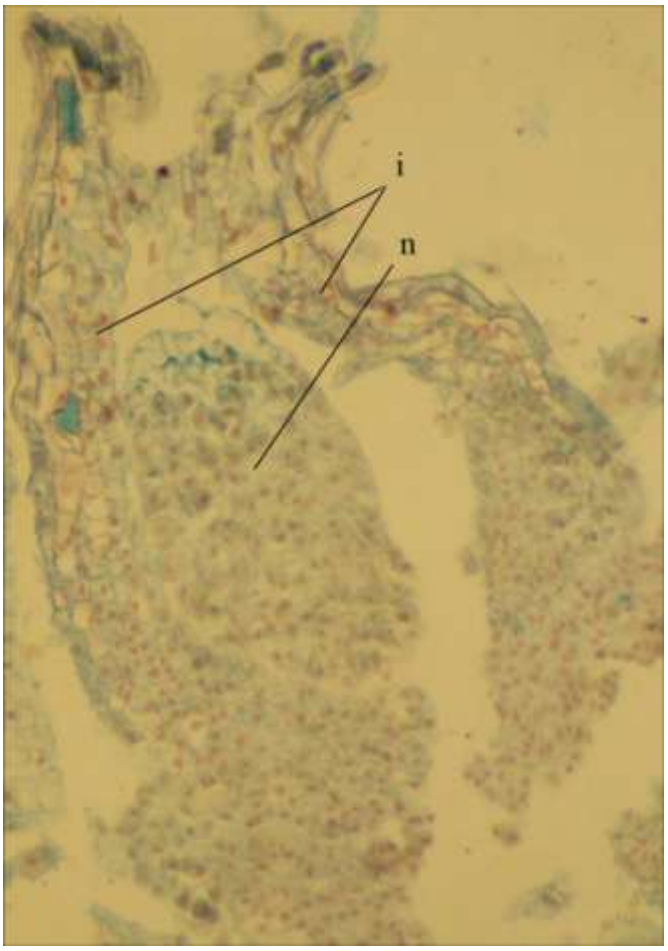

Fig.3 longitudinal section of *Torreya grandis* ovule during pollination
i-integument, n-nucellus

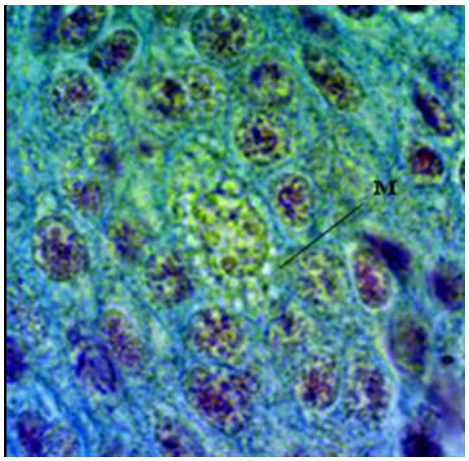

Fig.4 Mother cell of megaspore

Cells of basal space of nucellus are larger with thin covers. They become round as well and in the space between them blind pits emerge there, cytoplasm is friable and have some vacuoles. Integuments rises above nucellus, its bottom part consists of 5-7 rows of cells. Cells of external and interior epidermis of integument are prolonged with more dense cytoplasm in comparison with others, vacuoles have average size, cores are small with lack of nucleoli. In central part of integument the rest of degenerated cytoplasm and core occupy place along cell walls. Cells on the top of micropyle are like secretory cells – prolonged with thick cell covers, rather dense cytoplasm; core is large with small nucleolus and dense chromatin (fig.3).

Female generative sphere of *T. grandis* by pollination is on the phase of mother cell megaspore, which differentiate in basal part of nucellus. Mother cell of megaspore is much bigger than cells around, close to regular rectangular shape, dense cytoplasm and a large core with some nucleoli, located in the central part. Mother cell of megaspore contains starch grains. Cells, close to megasporocyte mutate – get regular quadrangular shape, while cores expend (fig.4). There is data that North American cultivar *Torreya nucifera* (L.) Siebold and Zucc. has anisochronous process of megasporocyte differentiation in ovule of one plant. Ultrastructural researches revealed that cytoplasm of mature megasporocyte contains small and medium-sized vacuoles, mitochondrions, ribosomes, smooth and folded reticulum, dictyosomes and storage compounds as starch grains and drops consisting of acid lipids [8]. Our observations correspond to these facts: out of 5 specimens yielded on the same day, only 3 ones have differentiated megasporocyte cell. In megasporocytes of *T.grandis* there are also starch grains and other storage compounds in the form of drops.

After pollination ovules stop developing. Next vegetative season (since the end of February till March) in pollinated ovules megasporocyte divides meiotically and forms 4 magaspores, where only one is functional but the rest degenerate. We fixed meiosis in ovules only, on their nucellus there were found pollen grains, that form pollen tube. In standard ovules functional megaspore forms nuclear free gametophyte due to a number of mitotic divisions. Female gametophyte get past the alveolar stage and in the end of May – beginning of June archegonial initial cells differentiate in the apical part. Since then till the second half of September there were no any considerable changes of ovules and female gametophyte. Probably that`s a result of daily average air temperatures, but from the other side ovules might have changes on the biochemical level. It should be noted that during the second half of September out of some differentiated archegonial initial cells (2-4) only 1 or 2 form archegones. In the end of September – beginning of October process of fecundation happens.

In unpollen ovules female gametophyte doesn`t develop, ovules degenerate (fig.5), but don`t fall off till the next spring. By the beginning of December in majority of collections megastrobiles have different size – some of them become larger than the rest. The main reason of ovule degeneration of coniferous is a lack of pollination. Mechanism of self-incompatibility is not so pronounced in comparison with angiosperms, and gets working as a result of secretory activity of integument and or nucellus cells, megagametophyte or ovule. Discharged secretions can decrease capacity to fecundate in case of self-pollination or cross pollination by closely related pollen without blocking it. So, mechanism of self-incompatibility of coniferous is possible to decrease seed production if degree of self-pollination is quite high [10, 11].

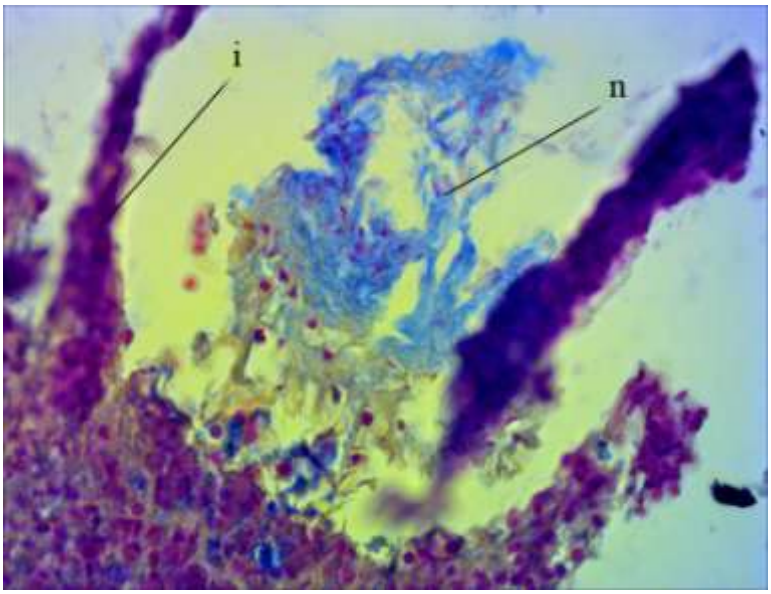

Fig.5 Degenerating ovule of Torreya grandis
i-integument, n-nucellus

Further development of ovules occurs the next vegetative season. In the beginning of April standard ovules are enclosed by 2 couples of pulpy scales and pulpy green cover. There is a big space between cover and ovule, micropylar part is oblong and close up with cover. Ovule is brown, dry and in the bottom (till the middle) there is some dried-up tissue that growing under favorable conditions forms pulpy ovule cover. A.V. Bobrov considers [1] this cover as the second integument, that forms testa differentiated on exo-, meso- and endoesta. *Torreya* cultivars flesh mesotesta contains a number of lysigenicous conceptacles.

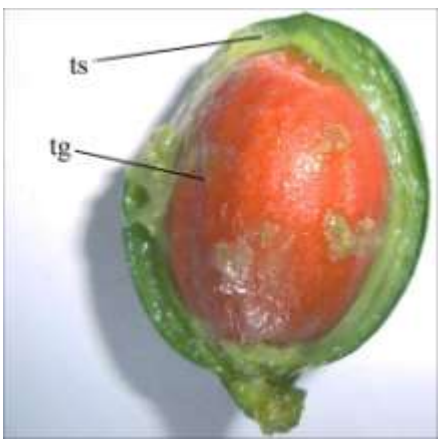

Fig.6 Mature seeds of Torreya grandis (tg-tegmen, ts-testa)

In the end of August – beginning of September seeds are considered mature. Their size is rather large (26,7 x 23 mm with cover, 21 x 14,7 without cover), coated with pulpy green testa and tegmen (ligneous cells) (fig.6). Semen is full of ruminate endosperm. Germ is quite small and has two immature cotyledons. The process of maturation demands long-term stratification.

Conclusions

As a result of researches it was determined that by pollination female reproductive structures of *T. grandis* get regular development while ovules are ready for new pollen grains. In NBG Arboretum by pollination process a number of regular developed ovules of *T. grandis*, ready to get pollen grains is 8-16 (mostly 12) per one generative shoot and 10000 per one tree. Efficiency of pollination depends upon weather conditions in this period. By pollination stage a mother cell of megaspore differentiates in the basal part of nucellus. Further development of female generative sphere occurs in pollinated ovules only. Period between pollination and fecundation continues 16-17 months, while from fecundation till seeds maturing - 11 months.

Seed ripening occurs in October-November, but there is a poorly developed germ which demands some time and stratification process to get maturing.

References

1. *Bobrov A.V.* Phylogeniya khvoinyh (analiz sovremennyh predstavleny) – M., 2002. – 193 s.

2. Katalog dendrologicheskih kollektsy Arboretuma Gosudarstvennogo Nikitskogo botanicheskogo sada / Sost: Galushko R.V., Zakharenko G.S., Kuznetsova V.M., Maksimov A.P., Mikhailenko D.M., Podgorny Yu.K., Silvestrova M.V., Shkarlet O.D. – Yalta: Pechatny tseh GNBS, 1993. – 101 s.

3. *Pausheva Z.P.* Praktikum po tsitologii rasteny. – M.: Kolos, 1980. – 304 s.

4. *Fursa D.I., Korsakova S.P., Amirdzhanov A.G., Fursa V.P.* Radiatsionny i hydrotermichesky rezhym Yuzhnogo berega Kryma po dannym Agrometeostantsii "Nikitsky sad" za 1930-2004 gg. i ego uchot v praktike vinogradarstva. – Yalta, 2006. – 54 s.

5. *Shevchenko S.V., Chebotar A.A.* Osobennosti embriologii masliny yevropeiskoy (Olea europaea) // Trudy Nikit.botan.sada – 1992. T. 113. S. 52-64.

6. *Belarbi* M., Bendimerad S., Sour S., Soualem Z., Baghdad C., Hmimed S., Chemat F., Visioli F. Oleaster oil positively modulates plasma lipids in humans // Journal of Agricultural Food Chemistry. – 2011. – Vol. 59. P. 8667–8669.

7. *Dong D.*, Wang H., Xu F., Xu C., Shao X., Li H. Supercritical Carbon Dioxide Extraction, Fatty Acid Composition, Oxidative Stability, and Antioxidant Effect of *Torreya grandis* Seed Oil // Journal of American Oil Chemistry Society. – 2014. – Vol. 91. – P. 817–825.

8. *Fiordi A.C.*, Lippi M.M., Marini S., Tani G. Ultrastruetural features of megasporogenesis in *Torreya nucifera* (Taxaceae) // P1ant Systematic and Evolution. – 1996. – Vol. 202. – P. 13-25.

9. Flora of China. 2014. World-wide electronic publication, eFloras.org. - http://www.efloras.org/florataxon.aspx?flora_id=2&taxon_id=200005500 – Searched on 12 October 2015.

10. *Owens J.N.* Constraints to seed production: temperate and tropical forest trees // Tree Physiology. - 1995. – Vol. 15. – P. 477—484.

11. *Takaso T.*, Owens J.N. Effects of ovular secretions on pollen in *Pseudotsuga menziesii* (Pinaceae) // American Journal of Botany. - 1994. – Vol. 81. – P. 504 -513.

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Ruguzova A.I. Female reproductive structures formation in *Torreya grandis* Fortune ex Lindl. under the conditions of the Southern coast of Crimea // Bull. of the State Nikit. Botan. Gard. – 2015. – № 117. – P. 47 – 54.

Data about calendar terms of *Torreya grandis* female reproductive structures formation in the conditions of the introduction have been presented in the article. It is demonstrated that in this species normally developed ovules are formed to the time of pollination. They carry megasporocyte. Further development of female generative sphere was noticed only in successfully pollinated ovules. It takes 16 – 17 months between pollination and fertilization and 11 months from fertilization to mature seeds. Mature seeds carry undeveloped embryo and they need the period of stratification.

Key words: *Torreya grandis, female reproductive structures, ovules, female gametophyte, seeds.*

BIOCHEMISTRY OF PLANTS

UDK 633.822:577.19

BIOLOGICALLY ACTIVE SUBSTANCES OF *SCUTELLARIA BAICALENSIS* GEORGI OF NIKITA BOTANICAL GARDENS COLLECTION

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Introduction

Scutellaria baicalensis Georgi is a valuable compendial medicine plant of Lamiaceae family. Its habitat is Eastern Transbaikalia (Chita district), Middle Priamurye (Amur district) and southwest Primorye (Primorsky krai). This perennial herbaceous plant is typically used in eastern medicine due to its broad-spectrum activity.

Medicine based on *Scutellaria baicalensis* Georgi has hypotensive, antivirus, anti-inflammatory, antitumoral, blood vessel strengthening, sedative and anticonvulsive properties, P-vitamin and antioxidant activity [10, 13-15]. Such preparations are prescribed to treat hypertension, functional disorder of nervous system, cardiovascular neuroses, myocardium, acute articular rheumatism, pneumonia, whooping cough and various types of bleeding [3,16].

Broad-spectrum of biologically active compounds, such as coumarin, tanning agents, essential oils, flavonoids and others cause pharmacological effects of this plant. A group of phenol compounds should be emphasized due to its high concentration and considerable structural variety.

Flavones takes the leading position among phenol substances of *Scutellaria baicalensis* Georgi. The following substances were found in its raw materials: chrysin, apigenin, scutellareine, isoscutellareine and luteolin [7, 12]. Nevertheless root materials are mainly applied in medicine, such substances as luteolin, apigenin and their glucuronids were discovered in overground plant parts [7]. Besides that overground part of *Scutellaria baicalensis* Georgi is notable for high concentration of carotinoides that reaches 74,6 mg per 100 g of air-dry raw material [15]. Chemical researches of vegetative changeability of overground materials reveals that the highest concentration of biologically active substances in raw materials of *Scutellaria baicalensis* Georgi is registered during mass flowering.

Chemical composition of *Scutellaria baicalensis* crude drug is determined by soil and climatic conditions of its cultivation. According to data of some authors concentration of phosphorus in soil favors deposit of all polysaccharide groups, while content of organic matter in soil (humus) determines content of carotinoids [8].

Allowing for pharmacological importance of this plant and correlation between concentration of biologically active substances in *Scutellaria baicalensis* and growing conditions [3], study of this plant biochemical composition under conditions of South Coast of the Crimea is current.

Objective of this work is to investigate qualitative and quantitative composition of biologically active substances (phenol matters, volatile compounds, vitamins) in a promising specimen, cultivated in Nikita Botanical Gardens being practically useful in production of medioprophylactic goods.

Objects and methods of the research

Research object was overground part of the promising *Scutellaria baicalensis* Georgi. specimen. Seeds of the starting material were ordered from German delectus. Raw material was obtained from introduction area of aromatic and medicinal plants of Nikita botanical gardens during mass flowering.

Scutellaria baicalensis Georgi. is a perennial herbaceous plant with not so large rhizome and pulpy main root. Height of plant growing on South Coast of the Crimea gets 73,0-74,5 sm, reproductive shoots are tetrahedral, branching from the bottom. Leaves are narrow lanceolate – 5,0-5,5 sm, opposite, sessile, smooth-edged. Flowers grow in one-sided bunch, 9-13 sm long. The bell is bilabiate, villous and campaniform on the top with special cup-shaped emergence (corymb) on the upper labium. Corolla is bilabiate, glandulosous from the outside, purple, 2,5-2,8 cm, with concave entire upper labium (helmet) and three-lobed lower labium. Crop capacity of the overground mass makes 1,67 kg/m^2 during mass flowering.

Concentration of biologically active substances was determined in aqueous ethanol extract consisted of air-dry raw material. Extraction was carried out by means of 50%-solution of ethanol having proportion of raw material and leach 1:10, preparing for 10 days at room temperature.

Component composition of phenol matters was determined applying chromatograph Agilent Technologies (model 1100), supplied with running vacuum degasifier G1378A, 4-ported low-pressure gradient pump G13111A, automatic injector G1313A, thermostat of columns G3116A, diode matrix detector G1316A. Chromatographic column 2,1-150 mm, filled with octadecyl sorbet "ZORBAX-SB C-18 with granulating 3,5 mkm was applied for analysis. Gradient regime of chromatography, specifying changes in eluting mixture of components A (0,1% orthophosphoric acid; 0,3% tetrahydrofyran; 0,018% trietilamine) and B (methanol) ratio were applied for analysis as well. Advance speed of mobile phase made 0,25 sm^3/min; working pressure of eluent was 240-300 kPa; sample size was 2 mkl, scan time – 0,5 sec; scale of measurements 0,1. Identification of phenol substances was carried out following the time of standard retention and spectrum characteristics (parameters of spectrum – each peak is 190-600 nm; waves length are 280, 313, 350, 37 nm) [11].

Component composition of volatile substances was determined by means of chromatograph Agilent Technology 6890 with mass-spectrometric detector 5973. Water heater HP-1 – 30 m, inside diameter – 0,25 mm. Thermostat temperature was programmed from 50 till 250°C with speed rate of 4°C/min. Injector temperature was 250°C. Gas carrier was Helium, stream velocity – 1 sm^3/min. During transformation from gas chromatograph to mass-spectrometric detector temperature was rosen up to 230°C. Source temperature was kept as 200°C. Electric ionization was carried out under conditions of 70 eV with mass

ranging m/z from 29 till 450. Identification was conducted basing on comparison of found mass-spectrums with data of combined library NIST05-WILEY2007 (about 500000 mass-spectrums) [4].

Results and discussion

As a result of conducted researches it was found out that extract of that *Scutellaria baicalensis* Georgi. specimen contains 18,5g of phenol substances per 100 g of air-dry material (fig.1, table 1). The study case contains 12 components as well, 10 of them were indentified. Exclusively flavanoids (flavones and flavanones) represented identified phenol compounds.

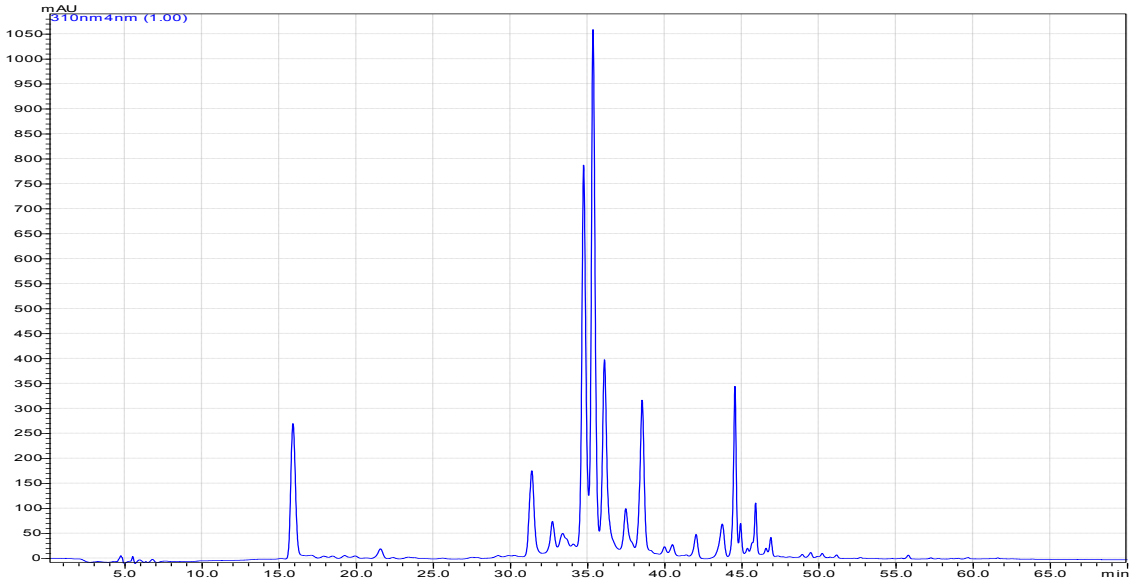

Fig.1 Chromatogram of phenol substances of water-ethanol *Scutellaria baicalensis* extract

Table 1

Phenol substances of water-ethanol *Scutellaria baicalensis* extract

№	Time of emission, min	Component	Concentration, mg/100 g of raw materials
1	15.88	Non-identified	1127,70
2	31.39	Dihydroscutellarine	998,16
3	32.71	Skutellarine-7- Glicozide	227,17
4	33.37	Dihydroscutellarine	427,91
5	34.56	Dihydroscutellarine	7646,20
6	35.34	Skutellarine -4- Glicozide	2164,96
7	36.08	Dihydroscutellarine	3424,39
8	37.46	Isoscutellarine -7- glucuronide	249,16
9	38.49	Apigenin -7- glucuronide	787,20
10	42.02	Baikaline	127,07
11	43.72	Apigenin	141,57
12	44.54	Skutellarine	515,19
13	44.91	Dihydrobaikaline	415,47
14	45.88	Non-identified	165,56
15	46.87	Dihydrobaikaline	93,01

By present most aspects of flavonoids biological activity have been identified, their P-vitamin activity has been known for a long time [1]. Flavonoids possess hepatoprotective,

antitumoral and antimicrobial effect, stimulate heart work and decrease blood tension for awhile [6]. In study case flavones prevails due to their various qualitative composition, but as to quantitative content flavanones do. Concentration of flavanones (70,3%) exceeds a lot concentration of other phenol compounds. Dominant component of phenol compounds (62,1% from the total content) is dihydroscutellarine what rather corresponds literary data [5].

Researching volatile compounds it was found out their concentration in water-ethanol extract of study case made 10,2 mg per 100 g of air-dry raw material. 25 components were identified in the extract (fig.2, table 2).

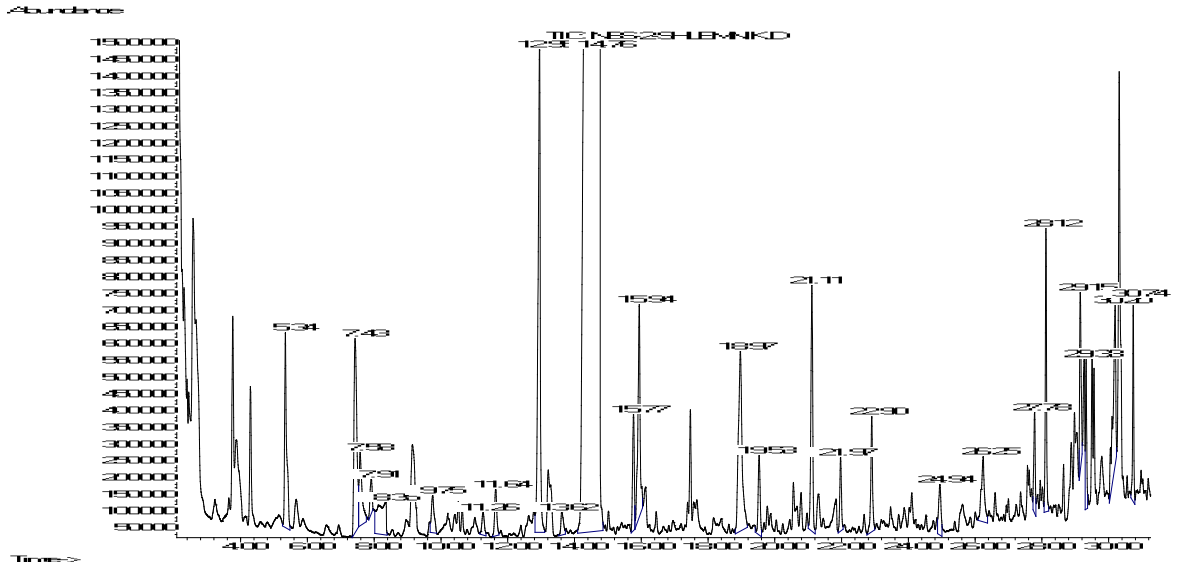

Fig.2 Chromatogram of volatile compounds in water-ethanol extract of *Scutellaria baicalensis*

Table 2

Volatile compounds in water-ethanol extract of *Scutellaria baicalensis*

№	Time of emission, min	Components	Mass fraction, %
1	2	3	4
1	5.34	Trans-2-Hexenal	5,41
2	7.43	1-octen-3-ol	7,78
3	7.57	Octanol-3	3,05
4	7.91	Trans-2-Heptenal	0,98
5	8.35	Capronic acid	3,84
6	9.75	2,4-heptadienal	1,48
7	11.25	linalool	0,79
8	11.63	nonanal	1,48
9	12.95	Phenylacetaldehyde	15,16
10	13.62	acetophenone	0,89
11	15.76	Para-vinyl-anisole	2,66
12	15.94	Ethyl Acetopyruvate	6,69
13	18.96	4- vinylphenol	9,25
14	19.53	β-bourbonene	2,17
15	21.11	β- caryophyllene	6,3
16	21.97	4-vinyl-2-methoxy-phenol	1,77
17	22.9	eugenol	2,95
18	24.94	δ-cadinene	1,67

19	26.24	lauric acid	2,85
20	27.78	caryophyllene	2,07
21	28.12	caryophylla-2(12),5-dien-13-al	5,22
22	29.15	caryophylla-4(12),8(13)-dien-5-ol	3,84
23	29.32	α-cadinol	2,46
24	30.19	myristinic acid	6,1
25	30.73	hexahydro farnesyl acetone	3,15

In total concentration of the study extract aromatic compounds prevail (39,37%). Considerable number of components in the extract are aliphatic compounds (32,97%): alcohols, aldehydes and acids. Concentration of terpenic compounds makes 27,67% of total amount of volatile substances. Terpenoids are represented by sesquiterpenoids (16,74%), sesquiterpenes (10,14%) and the only monoterpenoid – linalool, what is not considerable (0,79%). The dominant component of extract is phenylacetaldehyde (15,2%), 4-vinylphenol (9,2%), 1-octen-3-ol (7,8%). Phenylacetaldehyde possesses strong hyacinth aroma and in case of 2% dosage is possible to use in perfume compositions and various odorants, but 1-octen-3-ol has pronounced fungal smell and analogous appliance in case of 1% dosage [2].

Concentration of ascorbic acid in *Scutellaria baicalensis* extract made 115 mg/100g. Carotinoids content is 2,5mg/100g.

Content and composition research of biologically active substances revealed the study pattern of *Scutellaria baicalensis* is a promising source of flavonols (flavonones and flavones).

Conclusions

Quantitative and qualitative composition of biologically active substances (phenol substances, volatile) in aqueous-ethanol extract of *Scutellaria baicalensis* pattern cultivated on South Coast of the Crimea, was investigated in terms of this research.

At the same time it was determined that flavanons prevail among phenol substances. Dominant component is dihydroscutelarine.

Among volatile substances aromatic compounds dominate. The principal extract components were found phenilacetaldehyde, 4-vynilphenol and 1-octen-3-ol.

In extract of *Scutellaria baicalensis* concentration of vitamin (ascorbic acid and carotinoids) was identified as well.

Raw material of this *Scutellaria baicalensis* pattern is a valuable source of biologically active substances in the field of medioprophylactic production.

References

1. *Barabay V.A.* Biologicheskoye deistviye rastitelnyh fenolnyh soedineniy – Kiev: Nauk.dumka, 1976. – 162 s.

2. *Voitkevich S.A.* 865 dushystyh veshchestv dlya parfumerii i bytovoy khimii – M.: Pishchevaya promyshlennost, 1994. 594 s.

3. *Koldayev V.M., Zorikova O.G.* Otsenka summy flavanoidov v shlemnike baikalskom // Likarske roslynnytstvo: vid dosvidu mynulogo do novitnyh technology: materialy tretyoyi Mizhnarodnoyi naukovo-praktychnoyi konferentsii (Poltava, 15-16 travnya 2014 r.). – Poltava, 2014. – S. 113-117.

4. *Kriventsov V.I.* Metodicheskiye rekomendatsii po analizu plodov na biokhimichesky sostav – Yalta, 1982. – 22 s.

5. *Kutsyk A.V., Sereda A.V., Popova T.P., Rybachenko A.I., Litvinenko V.I.* Spektrometricheskoye opredeleniye flavanoidov v trave shlemnika baikalskogo // Farmakom. – 1998. - № 2. – S. 18-20.

6. *Maksyutina N.P., Komissarenko N.F., Prokorenko A.P., Pogodina L.I., Lipkan G.N.* Rastitelniye lekarstvenniye sredstva. – K.: Zdorovya, 1985. 280 s.

7. *Olennikov D.N., Chirikova N.K., Tankhayeva L.M.* Phenolniye soedineniya shlemnika baikalskogo (*Scutellaria baicalensis* Georgi) // Khimiya rast. syrya. – 2009. - № 4. – S. 89-98.

8. *Olennikov D.N., Chirikov N.K., Tankhayeva L.M.* Khimichesky sostav shlemnika baikalskogo (*Scutellaria baicalensis* Georgi) // Khimiya rast. syrya. – 2010. № 2. – S. 77-84.

9. *Pleshkov B.P.* Praktikum po biokhimii rasteny. – M.: Kolos, 1969. - 183 s.

10. *Leach F.S.* Anti-microbial properties of Scutellaria baicalensis and Coptis hinensis, two traditional Chinese medicines // Bioscience Horizons. – 2011. – Vol. 4. – № 2. – P. 119 – 127.

11. *Murrough M.I., Hennigan G.P., Loughrey M.J.* Quantitative analysis of hop flavonols using HPLC // J. Agric. Food Chem. – 1982. – Vol. 30. – P. 1102 – 1106.

12. *Olennikov D.N., Chirikova N.K., Tankhaeva L.M.* Phenolic Compounds of *Scutellaria baicalensis* Georgi // Russian J. of Bioorganic Chem. – 2010. – Vol. 36. – № 7. – P. 816 – 824.

13. *Sokoł-Łetowska A., Oszmiański J., Wojdyło A*. Antioxidant activity of the phenolic compounds of hawthorn, pine and skullcap // Food Chem. – 2007. – Vol. 103. – P. 853 – 859.

14. *Tserentsoo B., Boldbaatar J., Tserendagva D., Zorig T., Dagvatseren B., Oldokh S., Sanduijav R., Oyunsuren T.S.* Study of *in vitro* anti-cancer effect of *Scutellaria baicalensis* Georgi. ethanol extract // Topclass J. of Herb. Med. – Vol. 2(8) – P. 189 – 193.

15. *Tuan P.A., Kim Y.B., Kim J.K., Arasu M.V., Al-Dhabi N.A., Park S.U.* Molecular characterization of carotenoid biosynthetic genes and carotenoid accumulation in *Scutellaria baicalensis* Georgi // *EXCLI*. – 2015. – Vol. 14. – P. 146 – 157.

16. *Wu S., Sun A., Liu R.* Separation and purification of baicalin and wogonoside from the Chinese medicinal plant *Scutellaria baicalensis* Georgi by high-speed counter-current chromatography // J. of Chromatography A. – 2005. – Vol. 1066. – P. 243 – 247.

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The article covers study of qualitative and quantitative composition of aqueous-alcoholic extract of the *Scutellaria baicalensis* promising pattern. It was determined that content of phenol substances in this extract reaches 18,5 g/100g. Dominate phenol substances are flavanones (dihydroscutelarine). As to volatile substances aroma compounds prevail. Dominant extract components are phenylacetaldehyde (15,2 %), 4-vinylphenol (9,2%) and 1-octen-3-ol (7,8%). It was found out the extract contains ascorbic acid and carotinoids. In general, the study pattern can be considered as a source of biologically active substances, first and foremost, source of phenol compounds.

Key words: *Scutellaria baicalensis Georgi, aqueous-alcohol extract, phenol combinations, volatile compounds, vitamins.*

FLORICULTURE

UDK 582.998.1:581.41(477.75)

PERSPECTIVE ASSORTMENT OF CULTIVARS, SORTS AND CONCULTIVARS OF *ZINNIA* L. GENUS GROWING IN THE PIEDMONT ZONE OF THE CRIMEA

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Introduction

Principal task of introduction research is to mark out the most valuable, qualified for commissioning, gradation and practice in landscape gardening, cultivars among species diversity of ornamental plants.

This process is based on rate of morphological and biological properties of floral plants, noted for the economical and commercial value. Particularly, plant morphological characteristics of definite cultivar provide its ornamental features. Biological properties determine weather-, diseases- and pests-resistance, while economic value is expressed in adapting of blossoming terms and seed maturation, keeping of ornamental properties and seed productivity.

Though first and foremost introduction process consists in plant assortment, capable to adapt to new culture conditions based on botanical and geographical analysis and discovery of lands – climatic analogues.

Zinnia L. genera of Asteraceae family is an annual herbaceous plant, originated from Caribbean region of Neotropical floral kingdom (Home – Mexico). Its areal occupies North, Central and South America [6]. Its natural habitat is stony canyon ledges, 1500 m above the sea level [4]. After introduction *Zinnia* was widespread on territories, situated close to natural habitat as a flower crop, noted for diversity of ornamental characteristics and economic-biological properties that permit to adapt to dry summer and high level of insolation.

Hydrothermal coefficient (HTC) by G.T. Selivanov [7], base for identification of compliance to growing area climate, makes it possible to discuss that climatic peculiarities of plant habitat with dry and hot summer as well as habitat with quite wet winter (HTC under 0,5) could be a precondition for *Zinnia* L. introduction prospects rate in new edapho-climatic conditions of Piedmont Crimea (HTC under 0,7).

Zinnia as an annual floral crop with high adaptive capacity to new climatic conditions with high level of ornamentality is possible to replenish assortment of permanent flowering plants used within open sunny lands where air and soil temperature reaches considerable points above zero [3].

Z.violacea Cav. and *Z.haageana* Regel are the most widespread cultivars. About thousand cultivars has been selected by present, they are united into garden groups according to inflorescence construction, semifloret form and plant height [8].

Nowadays *Zinnia* can be found in catalogues of many botanical gardens in CIS and all over the world in general [9,10]. Though making collection funds is only precondition of the next introduction stage – comprehensive study, comparative cultivar rate and selection of the best species for floricultural points.

In spite of wide species diversity of *Zinnia* L., rather limited assortment is used in landscaping of cities and private areas. Investigation of biological and morphological peculiarities of species and cultivars from *Zinnia* L. genus, growing within Piedmont Crimea is still urgent task.

Study objective is to develop perspective assortment of *Zinna* L. genus for green building in piedmont zone of the Crimea. The objective is possible to implement due to complex cultivar rate of ornamental and economic-biological characteristics.

Objects and methods of the research

Study objects were three cultivars, ten species and four concultivars from *Zinna* L. genus, which were picked out of collection in Steppe department of Nikita Botanical Gardens – National Scientific Centre (NBG-NSC) and All-Russian research Institute for selection and seed-growing of floral and vegetable crops in Moscow region, and introduced in piedmont zone of the Crimea. Study cases: *Zinnia peruviana* L., *Z. haageana* Regel. and *Z. violacea* Cav., and derived species *Z. violacea*: 'Imperator', 'Mechta, 'Oreol, 'Solnechniye zaichiki, 'Golden Down', 'Lavandel', 'Orange King, 'Polar Bear', 'Purple Prince', 'Scarlet Flame', and concultivars 'Dahlia like mix, 'Liliput, 'Raduzhnaya mix, 'Chysantemum like smes'.

Method of descriptive morphology, state strain test were applied in terms of the research [4]. Phenological observations were guided by methodic of floral crop rate by V.N. Bylov [1]. Ornamentality and economic-biological properties were assessed according to 100-points system, which was modified for work with representatives of *Zinnia* L. genus; this system consists of: plant habitus, a number of n-th order shoots, length of flower-bearing stem, inflorescence color, size and form of inflorescence, total amount of flowers and inflorescences, degree of inflorescence doubling, abundance of blooming, blooming period, seed productivity, disease- and pest-resistance (especially resistance to oidium).

Findings were statistically processed.

Results and discussion

For the first time on base of TNU Botanical garden under conditions of Piedmont Crimea collection fond of *Zinnia* L. genus was formed. Total compatibility rate of ornamental and economical- biological characteristics inherent for *Zinnia* L. genus, is a criterion for introduction of flowering ornamental crops in landscaping within Piedmont Crimea.

As a result of cultivar assessment according to complex of ornamental and economic-biological characteristics of *Zinnia* L., which included study of morphological features of inflorescences, plant habitus, blooming period, the most prospective specimens were marked out of collection fond; they composed assortment, which was tested and recommended for landscaping within Piedmont Crimea.

Promising assortment included three cultivars (*Z. violacea*, *Z. peruviana*, *Z. haageana*), four sorts ("Sonechniye Zaichiki", "Polar Bear", "Purple Prince", Orange King"), three concultivars (Zinnia Dahlia Mix and Zinnia Chrysanthemum Mix, Lilliput Mix) of *Zinnia* L. and representatives of two garden groups – giant and dwarf zinnias. Garden group of giant zinnias is composed of specimens with dahlia inflorescences ("Orange King", "Polar Bear", "Prince Purple", concultivar Zinnia Dahlia mix) and Zinnia Chrysanthemum Mix (concultivar Zinnia Chrysanthemum Mix), while garden group of dwarf zinnias is represented by pompon inflorescences (concultivar Lilliput, cultivar "Solnechniye Zaichiki").

Z.violacea cultivar and concultivar description, that is assortment for landscaping within Piedmont Crimea is presented below.

Garden group – giant zinnias (Z. *elegans grandiflora robusta plenissima*)

Zinnia Dahlia Mix – 90 sm tall. Shooting system consists of central upright shoot 50 sm tall and laterals: 7 first-order shoots 45-50 sm long with 14 second-order shoots 30-35 sm

long which in turn form 10 third-order shoots 10-15 sm long. Central and first-order lateral shoots form 7 foliaceous pairs with opposite arrangement, while the following-order shoots form less number of them: second- order – 6, third-order – 5 pairs of leaf sheets. Central and lateral shoots end with dahlia inflorescences, their doubling degree varies from simple to densely doubling. Color range of semiflorets presents yellow, orange, crimson, red and vinous tints. Diameter and height of the central shoot inflorescence makes 8,8 sm and 4,7 sm, first-order – 7,9 sm and 4,0 sm, second-order – 7,2 sm and 3,7 sm, third-order – 6,7 sm and 3,5 sm respectively. Due to large morphometric parameters of inflorescences their number per plant doesn`t make more than 10-12 units over entire blooming period. Each inflorescence of all cultivar plants are capable to set viable seeds, which get ripening until frost.

Blooming period of the concultivar under conditions of Piedmont Crimea makes 67 days in case of non-seedling cultivation and 61 days if seedling cultivation is used. **Zinnia Chrysanthemum Mix –** height of plant makes 70 sm. Central upright shoot is 40 sm high with laterals: 8 first-order shoots 20-25 sm with 10 second-order shoots on them 20 sm long, where in turn 6 third-order shoots 10-15 sm high occur. Shoots are foliate, leaves are smooth-edged, opposite. On the central shoot 7 pairs appear, on first-order shoot - 6, second-order - 5, third-order - 3 leaf plates develop. Semifloret forms uncommon chrysanthemum – shaped inflorescences with oblong and twisted petals a bit. Half-double, double and densely double inflorescences of lilac, pink, carmine and beige color are typical for this concultivar. Over vegetative period about 7-8 inflorescences occur on one plant. Diameter and height of central shoot inflorescence makes 10,5 sm and 4,0 sm, first-order – 8,5 sm and 3,6 sm, second-order – 6,2 sm and 2,7 sm, third-order – 3,5 sm and 2,3 sm respectively. Seeds and inflorescences of the third-order don`t get ripening until frosts with Piedmont Crimea.

In case of seedling cultivation blooming period in Piedmont Crimea makes 41 days, and starts in the middle of July.

“Purple Prince” – 50 sm high. Shoot system is presented by central upright shoot 45 sm high and laterals: first-order – 10, second-order – 13, third-order – 6 shoots, 25 sm, 20 sm and 15 sm long respectively. The following order of shoots grows over the previous one, and as a result deflowered inflorescences are covered by leaf mass of the following shoots. On central and lateral shoots of the first-order 5-7 pairs develop, second-order – 5 pairs, third-order – 3 pairs of leaves with opposite leaf arrangement. Central shoot and laterals end with Dahlia – shaped inflorescences. Flowers on inflorescences can be classified into two types: semifloret (purple-crimson) and disk floret (yellow). In terms of one populations there is a point to talk about plants with simple and half-double inflorescences. Over the whole vegetative period 3-4 inflorescences on average develop on one plant. Diameter and height of the central inflorescence makes 7,0 sm and 4,2 sm, first-order inflorescences – 5,8 sm and 2,8 sm, second-order – 5,4 sm and 2,6 sm respectively. The third-order inflorescences don`t develop or blossom out, as they are subjected to frost damages on the stage of colored buds. Under conditions of Piedmont Crimea seeds collected from flowered inflorescences are capable to get ripening until the first air frosts in the middle of October – beginning of November.

Blooming period in the middle of May under conditions of Piedmont Crimea makes 71 days in case of sowing in open ground, but if seedling cultivation – 60 days.

“Polar Bear” – plants reaches 70 sm high. Shoot system is presented by central upright shoot 45 sm high and laterals: 6-7 first-order shoots 40-45 sm long, 11 second-order shoots on them 25-30 sm long where in turn 7 third-order shoots start developing, which don`t reach full length until first frosts and keep the stage of 2-4 leaf pairs. Leaf arrangement is opposite. On the central shoot 7 pairs of leaves develop, on the first-order shoots – 6 pairs, on the second-order shoots – 5 pairs, on the third-order - 3 pairs. Central shoots and laterals

end with Dahlia like mainly simple inflorescences, though population includes double and densely double as well. Inflorescence flowers are classified into two types: semifloret (white) and disk floret (yellow). At the same time there are plants with simple and half-double inflorescences in population. Over the whole vegetative period 3-4 inflorescences develop on one plant. Diameter and height of inflorescences on the central shoot and laterals is various. In this way than younger laterals than smaller morphometric parameters of inflorescences. Therefore diameter and height of the central inflorescence makes 6,8 sm and 3,4 sm, first-order inflorescence – 6,3 sm and 3,2 sm, second-order – 5,4 sm and 2,7 sm. Viable seeds develop on them under conditions of Piedmont Crimea in the end of September – beginning of October until the first frosts.

In the middle of May blooming period in Piedmont Crimea in case of sowing in the open ground makes 65 days, what is 9 days longer than using seedling cultivation.

"Orange King" – plant height gets 60 sm. Shooting system is a central shoot 30 sm high and laterals: first-order – 4, second-order 5 shoots, 30 sm and 20 sm long respectively. Laterals of the third and further orders don`t form. 7 pairs of leaves with opposite arrangement develop on the central shoot, on the first-order shoot – 6 paits, second-order – 5 pairs. Central shoots and laterals end with Dahlia-shaped inflorescences which have flowers of two types: semifloret (bright-orange) and disk floret (yellow). They develop half-double and double inflorescences. In total 3-4 inflorescences per one plant develop during vegetative period. Diameter and height of the central inflorescence make 7,0 sm and 4,2 sm, first-order – 7,4 sm and 2,5 sm, second-order – 8,1 and 3,0 sm respectively. Seeds are capable to get ripening until frosts.

Blooming period makes 68 days allowing for conditions of Piedmont Crimea and sowing in the open ground in the middle of May, while in case of seedling cultivation it is 55 days.

Garden group – dwarf zinnias (*Z. elegans flore pleno pumila*).

"**Lilliput**" – height of the compact and dense plant makes 35 sm. On the central shoot, there are 25-30 sm high, 7 first-order 30-35 sm long, 17 second-order shoots 25-30 sm and 19 third-order shoots 20-25 sm. Shoots are foliaceous wth opposite leaf arrangement. 6 pairs of leaves develop on the central shoot, on first and second-order – 5 pairs, third – 4 pairs. Developed pompon inflorescences on plants are composed of closely adjoining growing in a tile way along the full length semiflorets. They are lilac, carmine, white and pink – shadowed. In this way desk flowers keeps yellow color constantly. Within this sort, as an exclusion, there are plants with simple and double inflorescences. In total over the vegetative period on average 16-17 inflorescences develop per one plant, 4,8 sm across diameter and 2,8 sm high. Depending upon lateral order diameter and height of inflorescences ranges as follows: first-order – 4,5 sm and 2,3 sm, second-order – 3,3 sm and 1,7 sm. The third-order inflorescences aren`t capable to develop until frosts and stay on the stage of colored buds. The rest inflorescences form viable seeds under conditions of Piedmont Crimea.

Blooming period that starts under conditions of Piedmont Crimea applying non-seedling cultivation makes 55 days.

"Solnechniye zaichiki" – height of the compact plant makes 40 sm. Central shoot is upright and reaches 25 sm high. On average 38 laterals develop on the plant, 6 of them are first-order 30-35 sm long, 15 second-order shoots 20-25 sm long, 17 third-order shoots 15-20 sm long. Leaves with opposite arrangement develop on the central shoot – 5 pairs, first order – 6 pairs, second-order – 5 pairs and third-order shoots – 4 pairs. Bright yellow semifloret and desk flowers form inflorescences of several types: simple, half-double, double and pompon. On average 12-13 pompon inflorescences develop on the same plant. Diameter and height of the central inflorescence makes 3,7 sm and 2,65 sm, first-order inflorescences – 3,2

sm and 2,9 sm, second-order – 3,2 sm and 2,3 sm, third-order – 2,6 sm and 1,3 sm respectively.

Blooming period that starts in the end of July under conditions of Piedmont Crimea if open ground makes 78 days, while in case of seedling cultivation it starts in the middle of June and makes 58 days.

As a study assortment was divided into garden groups, cultivar rating covers general ornamental effect of this cultivar groups as well.

Comparative cultivar rating of two garden groups of giant and dwarf zinnias revealed that giant zinnias have more oblong, spready habitus form, which form 25-30 laterals, while dwarf compact zinnias have 38-43 laterals. Dwarf zinnias have more inflorescences (from 13-17) in comparison with giant zinnias (4-8) what increases their ornamental value [7].

In course of the research considerable powdery mildew susceptibility of zinnia plants was fixed, what decreases general ornamental effect of cultivars to a large degree. Thereby presowing treatment with complex fungicides and further spraying works is recommended during the rainy period. To prevent zinnias from fungal diseases they are cultivated on warm and open areas with well permeable soil and root irrigation in especially dense plantings of flower gardens.

As a result of blooming period assessment and blooming terms rate the following cultivars were marked out: early-, medium- and late-blooming cultivars. In this way for convenience *Zinnia* L. assortment could be classified into cultivars recommended for flower gardens with constant and variable blooming process. Cultivars recommended for constant blooming flower gardens, that is early-blooming ones, get inflorescence opening in the second decade of June, but blooming period lasts till the end of October - beginning of November depending upon first air frosts according to research years. Cultivars, recommended for flower gardens with variable blooming, that is medium- and late-blooming plants, demonstrate inflorescence opening since the third decade of June till the second decade of July, but blooming period lasts up to first frosts. Allowing for sequence of blooming cultivars and sorts of *Zinnia* L. could be recommended for composition flower gardens in combination with other annual plants that start up blooming earlier, but require the same irrigation and insolation regime as zinnias do. At the same time *Zinnia* L. cultivars and species could be combined with sorts of the same cultivar or other annual plants to gain round-year blooming. In such flower gardens zinnias are possible to accompany with summer-blooming *Tagetes patula* L., *Verbena officinalis* L., *Calendula officinalis* L. and autumn-blooming sorts of asters and chrysanthemums.

Zinnia L. cultivars and sorts that demonstrate permanent blooming can be recommended for homogeneous groups and lands. There are cultivars and sorts that start up blooming in the first decade of July: cultivar *Z. peruviana*, *Z.haageana* (04.07), sort “Oryol” (01.07), sort “Golden Down”, “Lavandel”, “Polar Bear” (04.07), concultivars Dahlia- and Chrysnthemum-like mixes (10.07).

Zinnia L. assortment recommended for Piedmont Crimea includes cultivars, sorts and concultivars, that present plants of different height, what extends use range of this flower crops in various flower gardens.

The most advantageous planting place for zinnias is one-sided or two-sided bed-borders. One-sided bed border is usually planned along building, edges and fences walls and along the perimeter of areas, that is why *Zinnia peruviana* L., *Z. violacea* and giant multicolored concultivars of Dahlia and Chrysanthemum Mixes could successfully form their base. Two-sided bed border located in the centre of an alley or a garden path, lawn, otherwise where it is well within view, could be supplemented by one-color cultivar *Z. Peruviana* sorts of *Z. violacea* “Golden Down”, “Lavandel”, “Orange King”, “Purple Prince”, “Scarlet Flame”. In this way external edges of two- and one-sided bed borders are possible to

emphasize with dwarf cultivar *Z. Haageana,* sorts of *Z. Violacea* “Solnechniye zaichiki” and “Lilliput” or various chipping gravel and pebble or crushed stone. So-called carpet annual flower beds or borders made of dwarf zinnias of these cultivars have spectacular view as well.

Cultivars and sorts differ not only by height, but peculiarities of the main ornamental characteristic – inflorescence. According to inflorescence structure, color and size diversity of sorts and concultivars are possible to combine for floristic compositions in urban landscaping and private territories, allowing for morphologic parameters of generative sphere and plant height under conditions of Piedmont Crimea.

One-colored zinnias with bright-colored inflorescences (“Oreol”, “Solnechniye Zaichiki”, “Orange King”, “Purple Prince”, “Lavandel”) do for not very high one-crop flower gardens, while sort mixes (dahlia, chrysanthemum, raduzhnaya) and concultivar “Lilliput” goes well in tiered flower gardens.

In this way representatives of two garden groups of *Zinnia* L. genus make different ornamental effect. Garden group of dwarf zinnias characterized by compact habitus with numerous laterals and impudent blooming could be recommended for floristic design of bed borders and parterre flower gardens. Garden group of giant zinnias with branchy shape of bush, not so many laterals and a few of large inflorescences could fit for multitiered flower gardens.

Conclusions

To extend assortment of drought-resistant annual flower crops in Piedmont Crimea the following was recommended: three cultivars of *Zinnia* L. genus (*Z. violacea*, *Z. peruviana*, *Z. haageana*), four sorts and three concultivars of *Z. violacea* “Solnechniye Zaichiki”, “Polar Bear”, “Prince Purple”, “Orang King”, “Lilliput”, Dahlia and Chrysanthemum Mixes with a high degree of ornamental properties and prolonged and impudent blooming period.

Blooming period in case of non-seedling cultivation is 10 days longer on average, than if seedling method is used. That`s why seed sowing into open ground is more reasonable in the second decade of May under conditions of Piedmont Crimea.

References

1. *Bylov V.N.* Osnovy sravnitelnoy sortootsenki dekorativnyh rasteny: avtoref.dis. na soisk. uchen. step. dok. biol. nauk: spets. 06.01.05 “Selektsiya i semenovodstvo”. - Moskva, 1979. – 43 s.

2. *Kudryavtsev D.B.* Takiye razniye tsinii // Tsvetovodstvo. – 2005. - № 3. – S. 34-36.

3. *Luks Yu.A.* Sostoyaniye nauchnyh issledovany po tsvetovodstvu i perspektivy ih razvitiya v Krymu. – Yalta, 1968. – S. 2.

4. Metodika gosudarstvennogo sortoispytaniya selskokhozyaistvennyh kultur. [Vyp.: dekorativniye kultury]. – M.: Kolos, 1968. – 222s.

5. Mirovoy agroklimatichesky spravochnik. – L.-M.: Hydrometeoizdat, 937. – 418 s.

6. Servis sohraneniya prirodnyh resursov [Elektronny resurs] Rezhym dostupa: http://plants.usda.gov/core/profile?symbol=ZIAN2

7. *Tukach S.I.* O biomorphologicheskyh osobennostyah sortov vida *Zinnia elegans* Jacq. V usloviyah Predgornoy zony Kryma // Visnyk Kyivskogo natsionalnogo Universitetu imeni T. Shevchenka. – Introduktsiya ta zberezhennya roslynnogo riznomanittya. 2009. – Vyp. 22-24. – S. 59-61.

8. *Tulintsev V.G.* Tsvetovodstvo s osnovami selektsii i semenovodstva: dop. uchebnoye posobiye. – L.: Stroyizdat, 1977. – 287 s.

9. Tsvetochniye dekorativniye rasteniya. Katalog. – Kiev: SElkhozizdat USSR, 1963. – 146 s.

10. *Frison E.A.*, *Serwinski J.* Direstory of European Institutions Holding Crop. Genetic resours. Collections. – 1995. – Vol. 1. – P. 154.

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Tukach S.I. Perspective assortment of cultivars, sorts and concultivars of *Zinnia* L. genus growing in the piedmont zone of the Crimea // Bull. of the State Nikit. Botan. Gard. – 2015. – № 117. – P. 59-66.

Collection stock of *Zinnia* L. genus growing in Piedmont zone of the Crimea was brought together for the first time. Assortment that includes three cultivars of *Zinnia* L., three cultivars and three concultivars of *Zinnia violacea* Cav. were tested and recommended for green building in the given region. According to results of introduction study and complex cultivar rating there is a description of biomorphologic, phenologic, ornamental peculiarities of cultivars and sorts belonging to *Zinnia* L. genus, which composed a new assortment for Piedmont Crimea conditions.

Key words: *Zinnia violacea* Cav*., Z. peruviana* L., *Zinnia* L. genus*, landscape gardening, perspective assortment, Piedmont zone of the Crimea.*

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ANCIENT TREES OF ARBORETUM OF NIKITSKY BOTANICAL GARDENS

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For the first time analysis of vital state and ecologic and ornamental characteristics … (summery)…

Key words: *key words, key words, key words, key words, key words, key words, key words, key words*

Introduction

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Objects and research methods

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Results and discussion

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Conclusions

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FIGURE PATTERN

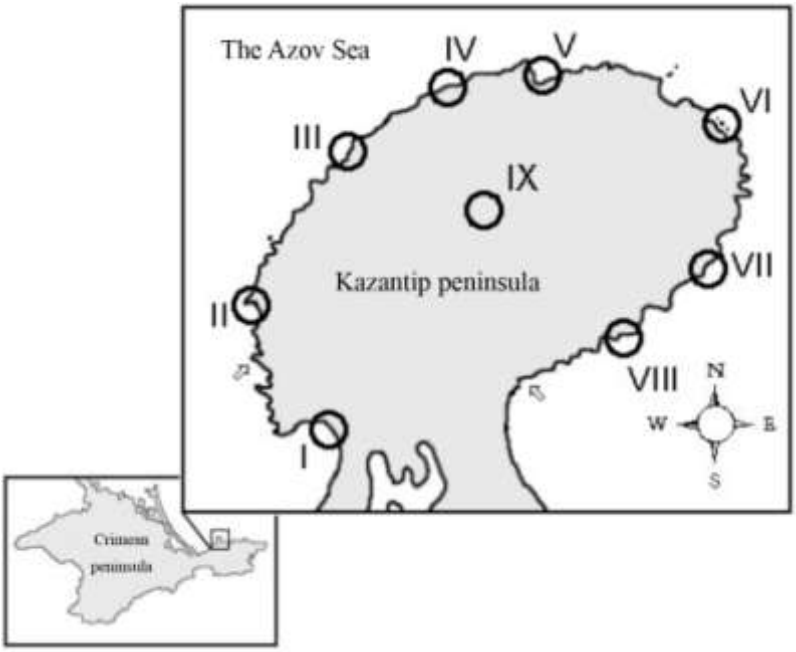

Fig. 1 Sketch map of inspected region (stations I-VIII)

TABLE PATTERN

Table 1

Cultivar composition and biomass of macrophytobenthos within offshore zone of Blessed Trinity Cape

Cultivar	Biomass, g/m^2 (stations I-IV)					
	PLR (±0,25 m)		SLR(–0,5-5 m)			
	I	II	III	IV	V	VI
Ulothrix flacca (Dillwyn) Thur.	F		F			
Chaetomorpha aërea (Dillwyn) Kütz.	F	F	15,00 ±3,92	1,67±0,72		F

Notes:
Hereinafter: PLR – pseudolittoral, SLT – sublittoral. F – few (less than 0,01 g in a sample).
Empty table cells mean absence of cultivar in samples.

16. Bibliographical references in article text are taken in square brackets, several sources are separated by commas in the order of number increasing.

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Books:

1. *Novosad V.V.* Flora Kerchensko-Tamanskogo regiona. – K.: Naukova dumka, 1992. – 275 s.
2. *Ostapkp V.M., Boiko A.V., Mosyakin S.L.* Sosudistiye rasteniya yugo-vostoka Ukraini. – Donetsk: Noulidzh, 2010. – 247 s.
3. Ekologichesky atlas Azovskogo morya / Gl.red.akad. G.G. Matyshov. – Rostov-na-Donu: Izd-vo UNC RAN, 2011. – 328 s.
4. Authors of plant names: A list of authors of scientific names of plants, with recommended standard forms of their names, including abbreviations / Eds. R.K. Brummitt and C.E. Powell. – Kew: Royal Botanical Gardens, 1992, reprinted 2001. – 732 p.

Periodicals and serials:

5. *Bagrikova N.A.* Analiz adventivnoj fraktsii flori prirodnih zapovednikov Kerchenskogo poluostrova (Krym) // Ekosystemi, ih optimizatsiya i ohrana. – 2011. – Vyp. 4(23). – S. 3 – 9.
6. *Nikiforov A.R.* Elementarnij pobeg i sezonnoye razvitiye rastenij *Silene jailensis* N.I.Rubtzov (Caryophyllaceae) – reliktovogo endemika Gornogo Kryma // Ukr.botan.journ. – 2011. – T. 68, № 4. – S. 552 – 559.
7. *Sadogurskij S.E.* Makrophitobentos vodoyomov ostrova Tuzla i prilegayushchih morskih akvatorij (Kerchenskij proliv) // Algologiya. – 2006. – T. 16, № 3. – S. 337 – 354.

8. *Hayden H.S., Blomster J., Maggs C.A., Silva P.C., Stanhope M.J., Waaland J.R.* Linnaeus was right all along: *Ulva* and *Enteromorpha* are not distinct genera // European Journal of Phycology. – 2003. – Vol. 38. – P. 277 – 294.

Abstract of a thesis:

9. *Belich T.V.* Raspredeleniye makrophitov psevdolitoralnogo poyasa na Yuzhnom beregu Kryma: Avtoref. Diss…kand. biol. nauk: 03.00.05 / Gosudarstvennij Nikitskij Botanicheskij Sad. – Yalta, 1993. – 22 s.

10. *Yena An.V.* Phenomen Florystychnogo endemizmu ta yogo proyavi u Krymu: Avtoref.dys. … d-ra boil. nauk: 03.00.05 / Instytut botaniki im. M.G. Kholodnogo NANU. – K., 2009. – 32 s.

Abstract of a paper:

11. *Sadogurskaya S.A., Belich T.V.* Algoflora pribrezhnoj akvatorii u mysa Troitsi (Chornoye morye) // Aktualniye problemi sovremennoj algologii: materialy IV mezhdunarodnoj konferentsii (Kiev, 20-23 aprelya 2012 g.). – K., 2012. – S. 258-259.

12. *Bagrikova N.A.* Syntaxonomical checklist of weed communities of the Ukraine: class Stellarietea mediae // 19-th International Workshop of European Vegetation Survey Flora, vegetation, environment and land-use at large scale (Pécs, 19.04–2.05, 2010): Abstr. – Pécs, 2010. – P. 51.

Section in a collective monograph:

13. *Bagrikova N.A., Kolomijchuk V.P. Astragalus reduncus* Pall. // Krasnaya kniga Priazovskogo regiona. Sosudistiye rasteniya / Pod red. d.b.n., prof. V.M. Ostapko, k.b.n., dots. V.P. Kolomijchuka. – K.: ALterpres, 2012. – S. 198 – 199.

14. *Korzhenevskij V.V., Rudenko M.I., Sadogurskij S.Yu.* PZ Krymskij // Phytoriznomanittya zapovidnykiv i natsionalnyh pryrodnyh parkiv Ukrainy. Ch.1. Biospherni zapovidnyky. Pryrodni zapovidnyky / Pid red. V.A. Onyshchenko i T.L. Andriyenko. – K.: Phytosotsiotsentr, 2012. – S. 198 – 220.

Multivolume editions:

15. Hydrometeorologiya i hydrokhimiya morej SSSR, T. IV. Chornoye morye. Vyp.1.Hydrometeorologicheskiye usloviya / Pod red. A.I. Simonova, E.N. Altmana. – SPb: Hydrometeoizdat, 1991. – 426 s.

16. Algae of Ukraine: Diversity, Nomenclature, Taxonomy, Ecology and Geography. Vol. 1. Cyanoprocaryota – Rhodophyta / Eds. Petro M. Tsarenko, Solomon P. Wasser, Eviator Nevo. – Ruggell: A.R.A.Gantner Verlag K.G., 2006. – 713 p.

Internet resources:

17. *Guiry M.D., Guiry G.M.* 2013. AlgaeBase. World-wide electronic publication, National University of Ireland, Galway. – http://www.algaebase.org. – Searched on 05 August 2013.

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