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.

The article was received at editors 26.10.2015

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

Anna Igorevna Ruguzova

Nikita Botanical Gardens – National Scientific Centre
298648, the Republic of Crimea, Yalta, urb.vil. Nikita
annaruguzova@ukr.net

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).

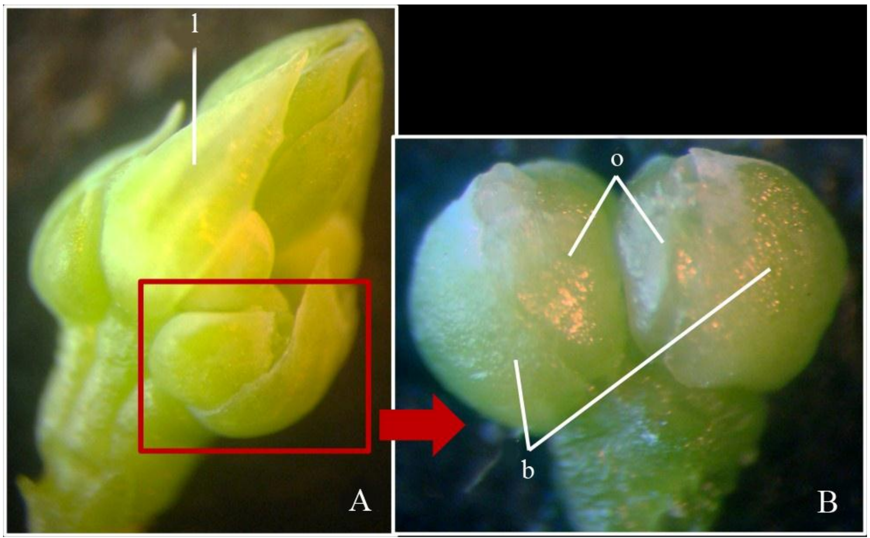

Fig.1 Megastrobil collections of Torreya grandis
A – megastrobil collections on vegetative and generative shoot, B – a couple of megstrobils in bracts axils, b – bract, l – leaf, o - ovule

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).

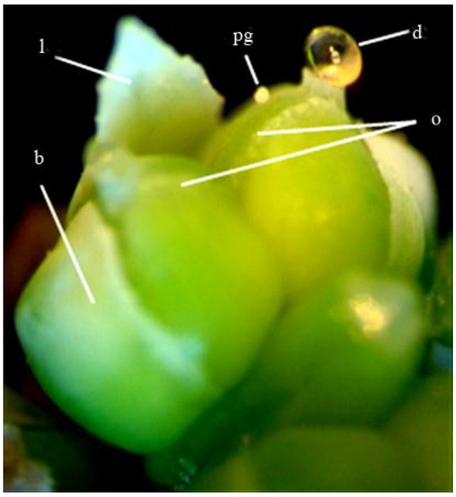

Fig.2 Ovule *Torreya grandis* during pollination, b – bract, d – pollinated drop, l – leaf, pg pollinated grain, o – ovule

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.

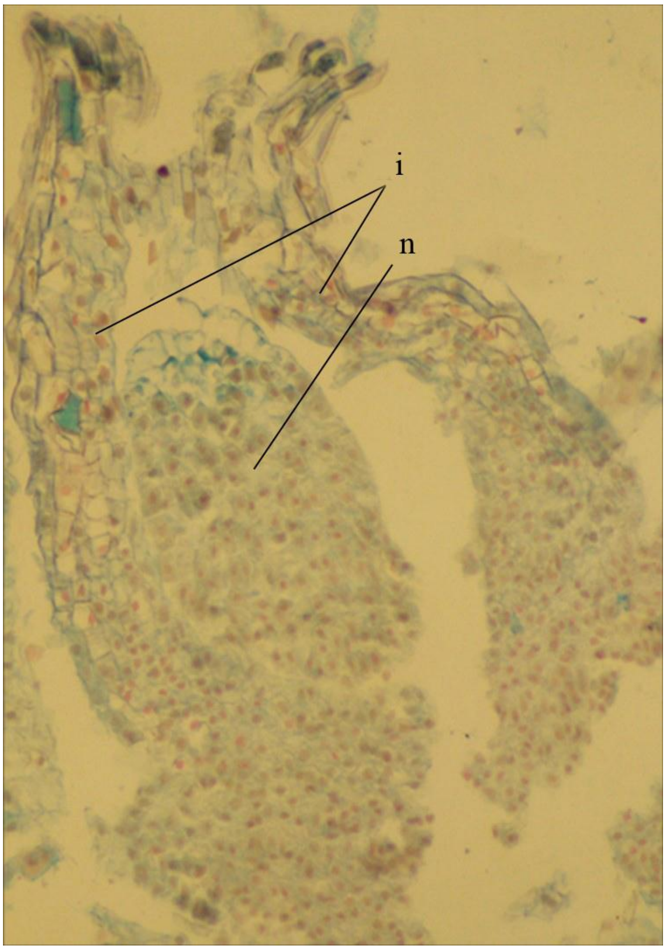

Fig.3 longitudinal section of *Torreya grandis* ovule during pollination i-integument, n-nucellus

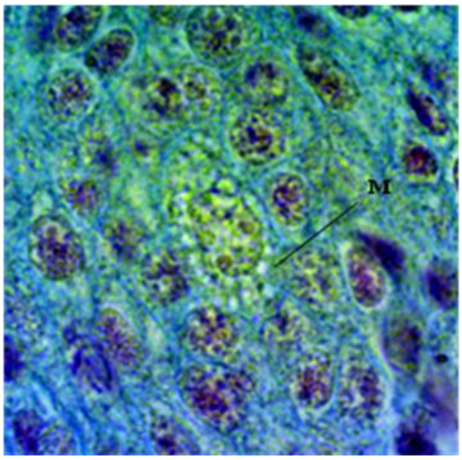

Fig.4 Mother cell of megaspore

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].

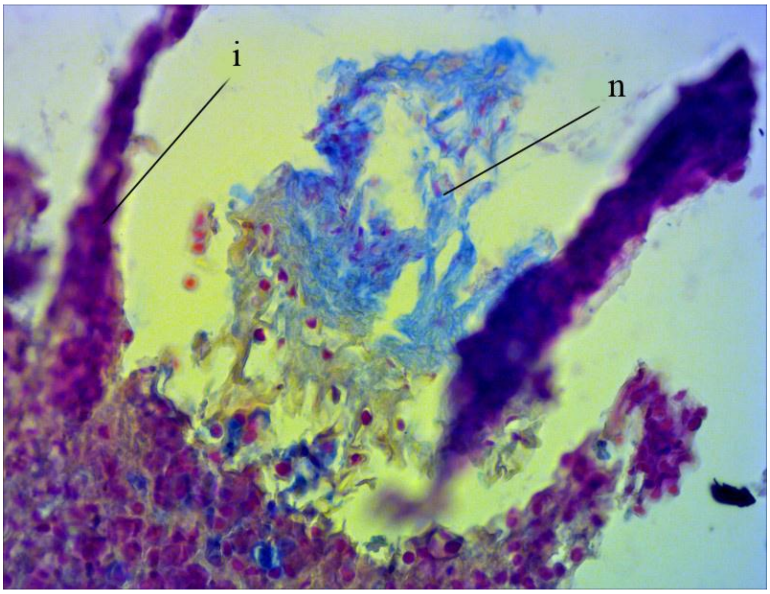

Fig.5 Degenerating ovule of Torreya grandis
i-integument, n-nucellus

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.

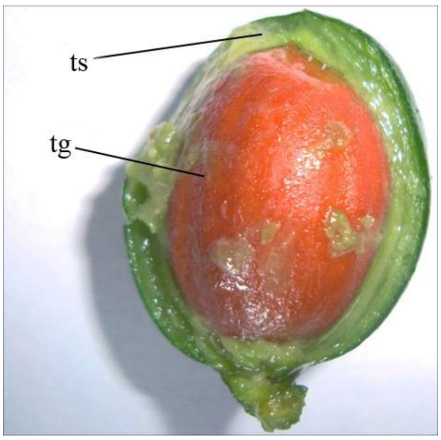

Fig.6 Mature seeds of Torreya grandis (tg-tegmen, ts-testa)

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.

The article was received at editors 21.10.2015

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

Oksana Anatolyevna Grebennikova, Anfisa Yevgenyevna Paliy, Lidiya Alekseyevna Logvinenko

Nikita Botanical Gardens – National Scientific Centre
298648, Republic of the Crimea, the city of Yalta, urb.vil. Nikita
oksanagrebennikova@yandex.ru

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.