ФІЗІОЛОГО-БІОХІМІЧНІ ТА ГЕНЕТИЧНІ ОСОБЛИВОСТІ ІНТРОДУКОВАНИХ РОСЛИН

УДК 633.88:581.13:577.13(470.21)

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THERMO DEPENDENT ACCUMULATION OF FLAVONOIDS BY ARBOREAL PLANTS INTRODUCED IN CIRCUMPOLAR NORTH

The character of flavonoids accumulation in arboreal plants introduced in Kola Subarctic and cultivated under various hydrothermal conditions is investigated. The high sensitivity of flavonoid pool to mainly temperature conditions of environment is found.

Regional-specific climate of Circumpolar Kola promote the accumulation in the indigenous plants physiologo-active constitutes of adaptiogenic type which enhance the survival capability of plants under conditions of permanent effects of various extreme factors. The aim of the paper presented to investigate this processes in relation to arboreal plants which were earlier resettled (introduced) in Kola Subarctic from various geographic habitats. As a criteria to evaluate the current state of introduced plants vegetated in such conditions the environmentally dependent level of accumulation of flavonoids components is offered.

Flavonoids — is one of the most and numerous and distributed groups of bio active phenolic compounds based on phenyl-propane carbon skeleton. Flavonoidic compounds can be presented either in glycosidic or in free forms, and those are capable as well to formation of chelate complexes with metals [14], which responsible for a whole array of adaptive physiologo-biochemical processes. The is a fine counterbalance of relations in plants between the protein synthesis and formation of flavonoidic components which can be redirected to the last under the unfavorable environmental changes. The intensification of protein synthesis result in decreasing of level of flavonoids formation and vise versa, the abatement of protein synthesis or their decay compensate by intensive formation of components of flavonoid group [9]. Owing to a wide spectra of pharmacological effects from a human perspective many phenolic compounds are of functional significance with respect to health-promoting properties. The main phenolic compounds in plants are flavonol glycosides, hydroxycinnamate conjugates, condensed tannins, anthocyanins. The properties of these compounds range from anti-malarial flavonoids, to those conferring food flavours, reduction of cardiovascular disease, and others which serve as antioxidants and anti-cancer compounds [3, 5, 6]. Earlier, it was shown also that flavonoids may more effective antioxidants than ascorbic acid or tocopherol [10].

The results of our earlier investigation show that capability of plants to flavonoids synthesis depends on global biospheric changes, local microenvironment, anthropogenic, industrial influence and on the weak modification of background conditions of vegetation [1, 2, 6, 7, 8, 13, 16].

For further exploration of environmental effects on synthesis and accumulation of flavonoids in arboreal plant species their contents were determined in foliage of plants cultivated both outdoors and indoors unheated plastic greenhouses (table 1) and hothouses. The artificial temperature variation under indoors conditions was considered as a the modeling of more southern latitudes environment. The content of flavonoids in vegetative or generative plant organs was determined in terms of absorption photometry via quantitative determination of complexes flavonoids with aluminum chloride and measurement absorption near 410 nm [4, 15].

Table 1

Microclimatic characteristics for cultivation conditions of introduced plants

Climatic indices	Growing conditions	Months	
		June	July
Diurnal mean temperature, °C	A	13,3	12,5
Diurnal mean temperature, °C	B	19,4	19,0
Maximal mean temperature, °C	A	18,8	18,0
Maximal mean temperature, °C	B	37,8	34,0
Mean diurnal air humidity, %	A	58,0	51,0
Mean dirnal air humidity, %	B	76,0	62,0

Comments. A — outdoors; B — unheated plastic greenhouse

The mean diurnal of air in June in experimental greenhouses was higher as compared with outdoors conditions by 6,1 °C; in July — by 6,5 °C. In June and in July mean maximal temperature of air in summer greenhouses overbalanced outdoors temperature by 19 °C and 16 °C, respectively. Mean diurnal outdoors humidity and in unheated greenhouses was dif-

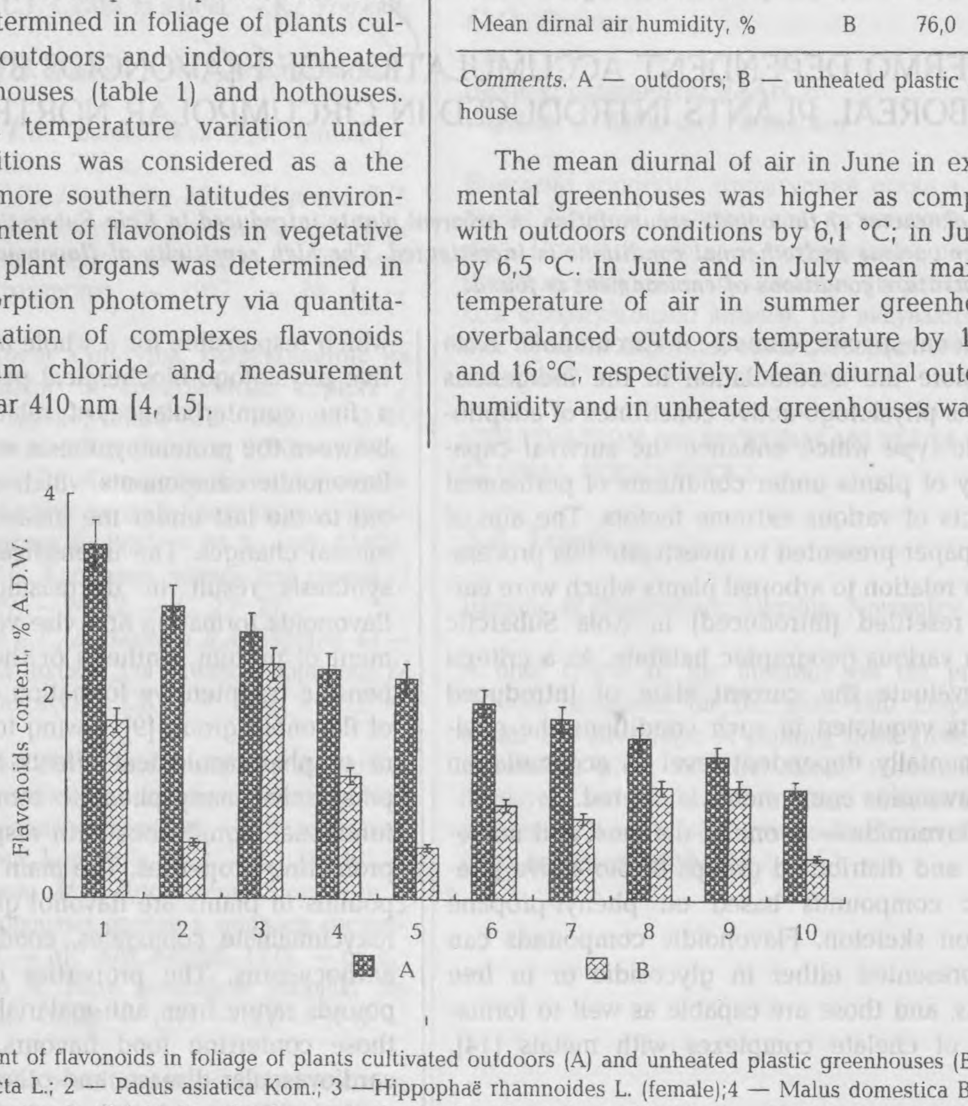

Fig. 1. The content of flavonoids in foliage of plants cultivated outdoors (A) and unheated plastic greenhouses (B): 1 — Clematis recta L.; 2 — Padus asiatica Kom.; 3 —Hippophaë rhamnoides L. (female);4 — Malus domestica Borkh.; 5 — Rubacer odoratum L. (Rybd.); 6 — Betula cenaica Evans; 7 — Rosa rugosa Thund.; 8 — Sorbus sibirica Hedl.; 9 — Syringa josikaea Jacq. fil.; 10 — Hippophaë rhamnoides L. (male)

ferentiated in June by 18 % and in July 16 %, respectively.

The mean level accumulation of flavonoids in conditions of summer greenhouses for used plants was two folds less as compared with outdoors (fig. 1). The most abatement was found for species Padus asiatica 5,3 fold and Rubacer odoratum — 4,3 fold. In male individuals Hippophaë rhamnoides (Eastern Sayani population) the band of this variation was 2,6 fold. In plants Rosa rugosa, Malus domestica, Betula cenaica и Clematis recta the content of flavonoids was twice more as compared with plants vegetated in greenhouses. The significant differences — 1,4 fold were found in Sorbus sibirica and Syringa josikaea.

For the comparative analysis of effects microenvironment the content of flavonoids was determined in the foliage of some tropical and subtropical species cultivated in hothouses (table 2).

Table 2

The content of flavonoids in foliage of hothouses plants, % absolute dry weight

The plant species	Flavonoids content
Arbutus unedo L.	0,17
Aspidistra clation Blume	0,28
Bougainvillea hybrida hort	0,01
Calathea zebrina (Sims.) Lindl.	0,36
Citrus limon (L.) Burrm f.	0,17
Crinum grandiflorum hort.	0,12
Cupressus sempervirens L.	0,31
Fatsia japonica (Thunb.) Decne. et Planch.	0,17
Ficus elastica Roxb. ex. Hornem.	0,17
Phoenix dactylifera L.	0,19

In these species only the trace quantity of flavonoids was found which changed within 0,01 % (Bougainvillea hybrida) to 0,36 % (Calathea zebrina).

On the base of conducted research one can claim that the most flavonoids level is accumulated in foliage plants provided their outdoors cultivation under conditions of the Kola North (the mean level — 2,13 %), and the minor — in plants, cultivated in hothouses with tropical climate (the mean — 0,2 %). The middle flavonoids accumulation capability showed the plants cultivated in unheated summer greenhouses, the mean is 1,07 %. The change in bio active constitutes content induced by hydrothermal regime is shown. The mean flavonoids of outdoors plant is exceeded the hothouse and greenhouse plants by 10,7 fold and by 2 fold, respectively. The significant differences (more than 5 fold) are exist also between plants cultivated in unheated greenhouses and hothouses.

The total foliage flavonoids of introduced plants vegetated in foothill valley and in the direct Khibiny mountains seemingly depends on microenvironment. Despite of little difference in altitude between compared points — the foothill valley situated at the 140 m a. s. l. meanwhile experimental nursery for introduced plants in Khibiny mountains at 340 m a. s. l. — under specific Circumpolar conditions this resulted in essential variation of hydrothermic indices. In Khibiny the period with temperature more than 5 °C can change within 75 to 125 days, meanwhile at foothills valley this band is 11 – 12 days longer. The mean multiannual summer of active temperatures (higher 10 °C) in Khibiny mountains is on 200 – 260 °C less as compared to foothill valley. The annual precipitation in Khibiny mountains consists as average 1200 мм, as on foothill valley — about 600 мм. This is reflected on the synthesis one of important biochemical component in local adaptiogenesis, namely flavonoids. As it seen on fig 2, the most high flavonoids constitutes are observed in plants growing in Khibiny mountains. The Lonicera chrysantha plant in foothill valley accumulates 3 fold less flavonoidic compounds as compared to plants located in Khibiny. Sorbus sambucifolia and Populus tristis in mountain conditions accumulate 2,5 fold more

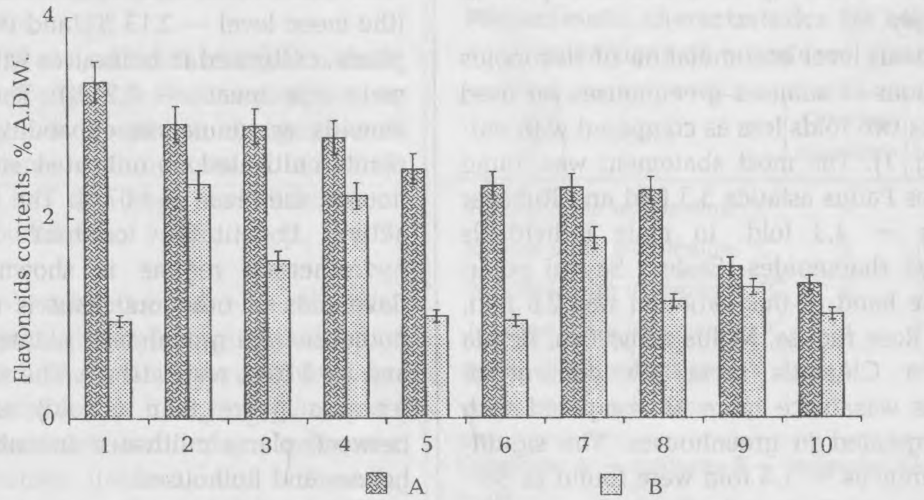

Fig. 2. The content of flavonoids in foliage of introduced plants growing under conditions of foothills valley (A) and Khibiny mountains (B):
1 — Lonicera chrysantha Turcz ex Ledeb; 2 — Rosa x kamtschatica Vent; 3 — Lonicera edulis Turcz ex Freyn; 4 — Spiraea salicifolia L.; 5 — Sorbus sambucifolia (Cham. et Shclecht.) M. Roem; 6 — Populus tristis Fisch.; 7 — Lonicera tatarica L.; 8 — Syringa wolfii Schneid.; 9 — S. villosa Vahl.; 10 — Berberis vulgaris L.

flavonoids as compared to the plain. In Syringa wolfii and Lonicera edulis in Khibiny the 2-fold exceeding of flavonids is found. Slightly less differences were revealed (1,2 fold) in Lonicera tatarica, Syringa villosa, Spiraea salicifolia, Berberis vulgaris and Rosa × kamtschatica.

The conducted research confirm the adaptation role of flavonoids. The more severe conditions for vegetation promote the elevated quantities of flavonoids. The comfortable conditions result in abrupt abatement of synthetic activity and decrease the flavonoids constitutes. The taxon dependent reaction on microclimatic factors exists and the content of flavonoids is seemingly determined by heredity determined adaptation potential of any specific object. This points on the important role of flavonoidic compounds in processes physiologo-biochemical adaptations to local changes and sporadic fluctuations of conditions of environment. The results obtained show that the most yield of bio flavonoids occurs under severe environmental conditions that points the way for enhancing of effectiveness in gathering and processing officinal plant raw-material.

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ТЕРМОЗАЛЕЖНЕ НАКОПИЧЕННЯ ФЛАВОНОЇДІВ ІНТРОДУКОВАНИМИ ЗА ПОЛЯРНЕ КОЛО ДЕРЕВНИМИ РОСЛИНАМИ

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Вивчено особливості накопичення флавоноїдів деревними рослинами, інтродукованими в умови Кольської Субарктики і культивованими у різних гідротермічних умовах. Виявлено високу чутливість вмісту флавоноїдів переважно до температурних умов навколишнього середовища.

ТЕРМОЗАВИСИМОЕ НАКОПЛЕНИЕ ФЛАВОНОИДОВ ДРЕВЕСНЫМИ РАСТЕНИЯМИ, ИНТРОДУЦИРОВАННЫМИ ЗА ПОЛЯРНЫЙ КРУГ

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Изучены особенности накопления флавоноидов древесными растениями, интродуцированными в условия Кольской Субарктики и культивируемыми в разных гидротермических условиях. Обнаружена высокая чувствительность содержания флавоноидов преимущественно к температурным условиям внешней среды.