SPECIES WITH POTENTIAL FOR ANTHOCYANINS EXTRACTION IN ARGEŞ COUNTY FLORA

SOARE Liliana Cristina, FERDEŞ Mariana, DOBRESCU Codruța-Mihaela

Abstract. The anthocyanins constitute a major flavonoid group, which is responsible for colours ranging from salmon-pink to red and violet to dark blue in plant tissues. Anthocyanin biosynthesis in plants is generally upregulated in response to one or more environmental stressors: strong light, UV-B radiation, temperature extremes, drought, ozone, nitrogen and phosphorus deficiencies, bacterial and fungal infections, wounding, herbivory, herbicides, and various pollutants. Anthocyanins are of interest for two reasons: they can be used in the technological field as natural colorants and have important implications in the field of human health. Numerous studies indicate the potential effect that this family of flavonoids may have in reducing the incidence of cardiovascular diseases, cancer, hyperlipidaemias and other chronic diseases through the intake of anthocyanin-rich foods. The anthocyanin distribution in plants is also important in chemotaxonomy. In the flora of Argeş county, there have been identified 242 species with potential for anthocyanins extraction. These species belong to 43 families; the greatest number of species characterizes the families: Asteraceae: 27, Lamiaceae: 26, Rosaceae: 21, Fabaceae: 17, Scrophulariaceae: 15, Campanulaceae: 12 and Violaceae: 10. 79.34% of the identified species can be used for the extraction of anthocyanins from flowers, 16.94 % from fruits, 2.90% from flowers and fruit, 0.82 % from leaves and bracts.

Keywords: anthocyanins, Argeş flora, flowers, fruits, leaves, bracts.

Rezumat. Specii cu potențial pentru extracția antocianilor din flora județului Argeş. Antocianii constituie un grup major de flavonoide responsabil pentru culorile ce variază de la roz-somon la roşu, violet până la albastru închis în țesuturile plantelor. În plante, biosinteza antocianilor este, în general, stimulată ca răspuns la unul sau mai mulți factori de stres din mediu: lumină puternică, radiații UV-B, temperaturi extreme, uscăciune, ozon, deficit de azot şi fosfor, infecții bacteriene şi fungice, răniri, specii ierbivore, ierbicide şi diferiți poluanți. Antocianii prezintă interes din două motive: ei pot fi utilizați în tehnologie, drept coloranți alimentari, dar şi în domeniul sănătății umane. Numeroase studii indică efectul potențial pe care această familie de flavonoide o poate avea în reducerea incidenței bolilor cardiovasculare, cancer, hiperlipidemie şi alte boli cronice prin aportul de alimente bogate în antociani. În flora județului Argeş au fost identificate 242 de specii cu potențial pentru extracția antocianilor. Acestea aparțin la 43 de familii, cel mai mare număr de specii aparținând familiilor: Asteraceae: 27, Lamiaceae: 26, Rosaceae: 21, Fabaceae: 17, Scrophulariaceae: 15, Campanulaceae: 12 şi Violaceae: 10. 79,34% dintre speciile identificate pot fi utilizate pentru extracția antocianilor din flori, 16,94 % din fructe, 2,90% din flori şi fructe, 0,82 % din frunze şi bractee.

Cuvinte cheie: antociani, flora județului Argeş, flori, fructe, frunze, bractee.

INTRODUCTION

The anthocyanins constitute a major flavonoid group, which is responsible for colours ranging from salmon-pink to red and violet to dark blue in plant tissues (ANDERSEN, 2008). Anthocyanins are present in vegetative and reproductive plant organs. More than 500 different anthocyanins have been identified. The most common anthocyanins in higher plants are: delphinidin, cyanidin, petunidin, pelargonidin, peonidin and malvidin. The glycosides of the three non-metylated anthocyanins (delphinidin, cyanidin and pelargonidin) are the most abundant in nature, representing 80% of leaf pigments, 69% in fruits and 50% in flowers. Anthocyanin biosynthesis in plants is generally upregulated in response to one or more environmental stressors (HATIER & GOULD, 2009). These include: strong light, UV-B radiation, temperature extremes, drought, ozone, nitrogen and phosphorus deficiencies, bacterial and fungal infections, wounding, herbivory, herbicides, and various pollutants (MCCLURE, 1975; CHALKER-SCOTT, 1999). Anthocyanins are interesting natural compounds that can be used as food colorants as they may display a wide range of attractive colours, they are water-soluble and have health-promoting effects. According to the numbering system used by the **Codex Alimentarius Commission,** anthocyanins (any anthocyanin-derived colorant) are listed as a natural colorant by the European Union (EU) legislation as product E163 (MATEUS & DE FREITAS, 2008). Anthocyanins have important implications in the field of human health. Numerous studies indicate the potential effect that this family of flavonoids may have in reducing the incidence of cardiovascular disease, cancer, hyperlipidemias and other chronic diseases through the intake of anthocyanin-rich foods. The anthocyanin distribution in plants is also important in chemotaxonomy. The aim of this study was to identify the species of plant from the spontaneous flora of Argeş county that can be used to extract anthocyanins.

MATERIAL AND METHODS

The list of species with potential for anthocyanins extraction was prepared on the basis of authors' own observations and data from literature (DRĂGHICI, 1968; DRĂGHICI & SOARE, 2002; NEBLEA, 2007; STANCU, 2005; ALEXIU, 2008). For each species was mentioned the organ (organs) that has potential for the extraction of anthocyanin pigments. Plants included in the list were selected based on specific color of anthocyanins. There were taken into account the frequent species (CIOCÂRLAN, 2009) and those that do not have very small flowers. Database made will serve to the further study of anthocyanin pigments contained in the organs of various species.

RESULTS AND DISCUSSIONS

There have been identified 242 species with potential for anthocyanins extraction in the flora of Argeş county. This species belong to 43 families. The families with the greatest number of species are: Asteraceae – 27, Lamiaceae – 26, Rosaceae – 21, Fabaceae – 17, Scrophulariaceae – 15, Campanulaceae – 12 and Violaceae – 10.

79.34% of the identified species can be used for the extraction of anthocyanins from flowers (fl.), 16.94 % from fruits (fr.), 2.90% from flowers and fruits, 0.82 % from leaves (lv.) and bracts (br.) (Fig. 1).

The list of species includes: **Aristolochiaceae:** 1. *Asarum europaeum* L. (fl.); **Ranunculaceae:** 2. *Aconitum moldavicum* HACQ. (fl.), 3. *A. tauricum* WULF. subsp. *tauricum* (fl.), 4. *Adonis aestivalis* L. (fl.), 5. *Consolida regalis* (DC.) S.F. GRAY subsp. *regalis* (fl.), 6. *Heleborus purpurascens* WALDST. et KIT. (fl.), 7. *Nigella arvensis* L. (fl.), 8. *Thalictrum aquilegiifolium* L. (fl.); **Papaveraceae:** 9. *Corydalis cava* SCHWEIGG. et KÖRTE (fl.), 10. *C. solida* (L.) CLAIRV. (fl.), 11. *Papaver rhoeas* L. (fl.); **Caryophyllaceae:** 12. *Dianthus carthusianorum* L. (fl.), 13. *Kohlrauschia prolifera* (L.) KUNTH (fl.), 14. *Lychnis flos-cuculi* L. (fl.), 15. *Silene acaulis* (L.) JACQ. subsp. *acaulis* (fl.); **Polygonaceae:** 16. *Polygonum bistorta* L. (fl.), 17. *P. hydropiper* L. (fl.), 18. *P. minus* HUDSON (fl.), 19. *P. mite* SCHRANK (fl.), 20. *P. persicaria* L. (fl.), 21. *P. viviparum* L. (fl.), 22. *Rumex alpinus* L. (fr.), 23. *R. obtusifolius* L. subsp. *obtusifolius* (fr.); **Plumbaginaceae:** 24. *Limonium gmelinii* (WILLD.) O. KUNTZE (fl.); **Grossulariaceae:** 25. *Ribes alpinum* L. (fr.), 26. *R. petraeum* WULFEN in JACQ. (fr.); **Saxifragaceae:** 27. *Saxifraga oppositifolia* L. subsp. *oppositifolia* (fl.); **Rosaceae:** 28. *Crataegus monogyna* JACQ subsp. *monogyna* (fr.), 29. *Fragaria vesca* L. (fr.), 30. *F. viridis* WESTON subsp. *viridis* (fr.), 31. *Geum rivale* L. (fl.), 32. *Cerasus avium* (L) MOENCH (fr.), 33. *Prunus spinosa* L. subsp. *spinosa* (fr.), 34. *Rosa canina* L. (fl., fr.), 35. *R. corymbifera* BORKH. (fl., fr.), 36. *R. gallica* L. (fl., fr.), 37. *R. pendulina* L. (fl., fr.), 38. *R. tomentosa* SM. (fl., fr.), 39. *Rubus caesius* L. (fr.), 40. *R. canescens* DC. (fr.), 41. *R. hirtus* W. et K. (fr.), 42. *R. idaeus* L. (fr.), 43. *R. montanus* LIB. ex LEJ. (fr.), 44. *R. praecox* BERTOL. (fr.), 45. *R. radula* WEIHE ex BOENN. (fr.), 46. *R. sulcatus* VEST ex TRATT. (fr.), 47. *Sanguisorba minor* SCOP. subsp. *minor* (fl.), 48. *S. officinalis* L. (fl.); **Fabaceae:** 49. *Coronilla varia* L. (fl.), 50. *Galega officinalis* L. (fl.), 51. *Lathyrus hirsutus* L. (fl.), 52. *L. niger* (L.) BERNH. (fl.), 53. *L. nissolia* L. (fl.), 54. *L. sylvestris* L. (fl.), 55. *L. tuberosus* L. (fl.), 56. *L. vernus* (L.) BERNH. (fl.), 57. *Ononis arvensis* L. (fl.), 58. *Trifolium alpestre* L. (fl.), 59. *T. medium* L. (fl.), 60. *T. pratense* L. (fl.), 61. *Vicia cracca* L. (fl.), 62. *V. dumetorum* L. (fl.), 63. *V. sepium* L. (fl.), 64. *V. tenuifolia* ROTH (fl.), 65. *V. villosa* ROTH (fl.); **Lythraceae:** 66. *Lythrum salicaria* L. (fl.); **Onagraceae:** 67. *Chamerion angustifolium* L. (fl.), 68. *Ch. dodonaei* VILL. (fl.), 69. *Epilobium collinum* C.C. GMELIN (fl.); **Thymelaeacea:** 70. *Daphne mezereum* L. (fl., fr.); **Cornaceae:** 71. *Cornus mas* L. (fr.), 72. *C. sanguinea* L. (fr.); **Celastraceae:** 73. *Euonymus europaeus* L. (fr.), 74. *E. verrucosus* SCOP. (fr.); **Rhamnaceae:** 75. *Frangula alnus* MILLER (fr., med., tinct.), 76. *Rhamnus cathartica* L. (fr.); **Geraniaceae:** 77. *Geranium palustre* L. (fl.), 78. *G. phaeum* L. (fl.), 79. *G. pratense* L. (fl.), 80. *G. robertianum* L. (fl.), 81. *G. sylvaticum* L. (fl.); **Linaceae:** 82. *Linum austriacum* L. (fl.), 83. *L. perenne* L. (fl.); **Polygalaceae:** 84. *Polygala amara* L. (fl., med.), 85. *P. major* JACQ. subp. *major* (fl.), 86. *P. vulgaris* L. subsp. *vulgaris* L. (fl., med.); **Apiaceae:** 87. *Ligusticum mutellina* (L.) CRANTZ (fl.); **Malvaceae:** 88. *Lavatera thuringiaca* L. (fl.), 89. *Malva sylvestris* L. (fl.); **Violaceae:** 90. *Viola ambigua* WALDDST. et KIT. (fl.), 91. *V. canina* L. (fl.), 92. *V. collina* Besser (fl.), 93. *V. dacica* BORBÁS (fl.), 94. *V. declinata* W. et K. (fl.), 95. *V. hirta* L. (fl.), 96. *V. mirabilis* L. (fl.), 97. *V. odorata* L. (fl.), 98. *V. reichenbachiana* JORDAN ex BOREAU (fl.), 99. *V. riviniana* REICHENB. (fl.); **Brassicaceae:** 100. *Dentaria bulbifera* (L.) CRANTZ (fl.); **Ericaceae:** 101. *Brukenthalia spiculifolia* (SALISB.) REICHENB. (fl.), 102. *Rhododendron myrtifolium* SCHOTT et KOTSCHY (fl.), 103. *Vaccinium myrtillus* L. (fr.), 104. *V. vitis-idaea* L. (fr.); **Primulaceae:** 105. *Anagallis arvensis* L. (fl.), 106. *Cortusa matthioli* L. (fl.), 107. *Primula minima* L. (fl.), 108. *Soldanella major* (NEILR.) VIERH. (fl.), 109. *S. pusilla* BAUMG. (fl.); **Gentianaceae:** 110. *Centaurium erythraea* RAF. subsp. *erythraea* (fl.), 111. *Gentiana acaulis* L. (fl.), 112. *G. asclepiadea* L. (fl.), 113. *G. nivalis* L. (fl.), 114. G. *verna* L. (fl.), 115. *Gentianella amarella* (L.) BÖRNER (fl.), 116. *G. austriaca* (A. et J. KERN.) HOLUB (fl.); **Apocynaceae:** 117. *Vinca herbacea* WALDST. et KIT. (fl.); **Oleaceae:** 118. *Ligustrum vulgare* L. (fr.); **Boraginaceae:** 119. *Anchusa officinalis* L. (fl.), 120. *Cynoglossum officinale* L. (fl.), 121. *Echium vulgare* L. (fl.), 122. *Lythospermum purpurocaeruleum* L. (fl.), 123. *Myosotis alpestris* F.W. SCHMIDT (fl.), 124. *Pulmonaria mollis* WULFEN ex HORNEM. (fl.), 125. *P. rubra* SCHOTT (fl.), 126. *Symphytum officinale* L. subsp. *officinale* (fl.); **Lamiaceae:** 127. *Acinos alpinus* (L.) MOENCH subsp. *alpinus* (fl.), 128. *A. arvensis* (LAM.) DANDY (fl.), 129. *Ajuga genevensis* L. (fl.), 130. *A. reptans* L. (fl.), 131. *Clinopodium vulgare* L. (fl.), 132. *Galeopsis ladanum* L. (fl.), 133. *G. tetrahit* L. (fl.), 134. *Glechoma hederacea* L. (fl.), 135. *G. hirsuta* WALDST. et KIT. (fl.), 136. *Lamium amplexicaule* L. (fl.), 137. *L. maculatum* L. subsp. *maculatum* (fl.), 138. *L. purpureum* L. (fl.), 139. *Origanum vulgare* L. (fl.), 140. *Prunella grandiflora* (L.) SCHOLLER (fl.), 141. *P. vulgaris* L. (fl.), 142. *Salvia nemorosa* L. (fl.), 143. *S. pratensis* L. subsp. *pratensis* (fl.), 144. *S. verticilata* L. (fl.), 145. *Scutellaria altissima* L. (fl.), 146. *S. galericulata* L. (fl.), 147. *S. hastifolia* L. (fl.), 148. *Stachys germanica* L. (fl.), 149. *S. officinalis* (L.) TREV. (fl.), 150. *S. palustris* L. (fl.), 151. *S. sylvatica* L. (fl.), 152. *Teucrium chamaedrys* L. (fl.); **Scrophulariaceae:** 153. *Bartsia alpina* L. (fl.), 154. *Melampyrum bihariense* A. KERN. (br.), 155. *Pedicularis verticillata* L. (fl.), 156. *Verbascum phoeniceum* L. (fl.), 157. *Veronica austriaca* L. (fl.), 158. *V. teucrium* L. (fl.), 159. *V. chamaedrys* L. subsp. *chamaedrys* (fl.), 160. *V. hederifolia* L. subsp. *hederifolia* (fl.), 161. *V. officinalis* L. (fl.), 162. *V. opaca* FR. (fl.), 163. *V. persica* POIR. (fl.), 164. *V. polita* FR. (fl.), 165. *V. spicata* L. subsp. *spicata* (fl.), 166. *V. orchidea* CRANTZ (fl.), 167. *V. urticifolia* L. (fl.); **Solanaceae:** 168. *Atropa belladonna* L. (fr.), 169. *Solanum dulcamara* L. (fl.), 170. *S. nigrum* L. (fr.); **Lentibulariaceae:** 171. *Pinguicula vulgaris* L. (fl.); **Campanulaceae:** 172. *Campanula alpina* JACQ. (fl.), 173. *C. bononiensis* L. (fl.), 174. *C. cervicaria* L. (fl.), 175. *C. cochleariifolia* LAM. (fl.), 176. *C. glomerata* L. subsp. *glomerata* (fl.), 177. *C. patula* L. (fl.),

178. *C. persicifolia* L. (fl.), 179. *C. rapunculoides* L. (fl.), 180. *C. rapunculus* L. (fl.), 181. *C. sibirica* L. (fl.), 182. *C. trachelium* L. (fl.), 183. *Phyteuma orbiculare* L. (fl.); **Caprifoliaceae:** 184. *Lonicera xylosteum* L (fr.), 185. *Sambucus ebulus* L. (fr.), 186. *S. nigra* L. (fr.), 187. *S. racemosa* (fr.), 188. *Viburnum opulus* L. (fr.), 189. *V. lantana* L. (fr.); **Dipsacaceae:** 190. *Knautia arvensis* (L.) J.M.COULT. subsp. *arvensis* (fl.), 191. *Knautia arvensis* (L.) J. M. COULT. subsp. *rosea* (BAUMG.) SOÓ (fl.), 192. *K. dipsacifolia* KREUTZER subsp. *lancifolia* (HEUFF.) EHREND. (fl.); **Asteraceae:** 193. *Arctium lappa* L. (fl.), 194. *A. minus* BERNH. (fl.), 195. *A. tomentosum* MILL. (fl.), 196. *Aster alpinus* L. (fl.), 197. *A. amellus* L. (fl.), 198. *Carduus acanthoides* L. (fl.), 199. *C. crispus* L. subsp. *crispus* (fl.), 200. *C. personata* (L.) JACQ. subsp. *personata* (fl.), 201. *Centaurea apiculata* LEDEB. subsp. *spinulosa* (ROCHEL) DOSTÁL (fl.), 202. *C. micranthos* S.G. GMEL. ex HAYEK (fl.), 203. *C. cyanus* L. (fl.), 204. *C. phrygia* L. (fl.), 205. *C. scabiosa* L. (fl.), 206. C. *stenolepis* A. KERN. subsp. *stenolepis* (fl.), 207. *Cicerbita alpina* (L.) WALLR. (fl.), 208. *Cichorium inthybus* L. subsp. *inthybus* (fl.), 209. *Cirsium arvense* (L.) SCOP. (fl.), 210. *C. canum* (L.) ALL. (fl.), 211. *C. palustre* (L.) SCOP. (fl.), 212. *C. rivulare* (JACQ.) ALL. (fl.), 213. *C. vulgare* (SAVI.) TEN. (fl.), 214. *C. waldsteinii* ROUY (fl.), 215. *Eupatorium cannabinum* L. (fl.), 216. *Onopordon acanthium* L. (fl.), 217. *Prenanthes purpurea* L. (fl.), 218. *Serratula tinctoria* L. (fl.), 219. *Xeranthemum annuum* L. (fl.); **Trilliaceae:** 220. *Paris quadrifolia* L. (fr.); **Liliaceae:** 221. *Colchicum autumnale* L. (fl.), 222. *Convallaria majalis* L (fr.), 223. *Erythronium dens-canis* L. subsp. *dens-canis* (lv.), 224. *Lilium martagon* L. (fl.), 225. *Muscari comosum* (L.) MILL. (fl.), 226. *Scilla bifolia* L. subsp. *bifolia* (fl.), 227. *Majanthemum bifolium* (L.) F. W. SCHMIDT (fr.), 228. *Polygonatum latifolium* (JACQ.) DESF. (fr.), 229. *P. odoratum* (MILL.) DRUCE (fr.), 230. *P. verticilatum* (L.) ALL. (fr.); **Alliaceae:** 231. *Allium scorodoprasum* L. (fl.), 232. *A. lusitanicum* LAM. (fl.); **Iridaceae:** 233. *Crocus vernus* (L.) HILL. (fl.), 234. *Gladiolus imbricatus* L. (fl.), 235. *Iris graminea* L. (fl.), 236. *I. ruthenica* KER-GAW. (fl.), 237. *I. sibirica* L. (fl.); **Orchidaceae:** 238. *Dactylorhiza cordigera* (FR.) SOÓ subsp. *cordigera* (fl.), 239. *Dactylorhiza maculata* (L.) SOÓ subsp. *maculata* (fl.), 240. *Gymnadenia conopsea* (L.) R. BR. (fl.), 241. *Orchis coriophora* L. subsp. *coriophora* (fl.); **Araceae:** 242. *Arum maculatum* L. (fr.).

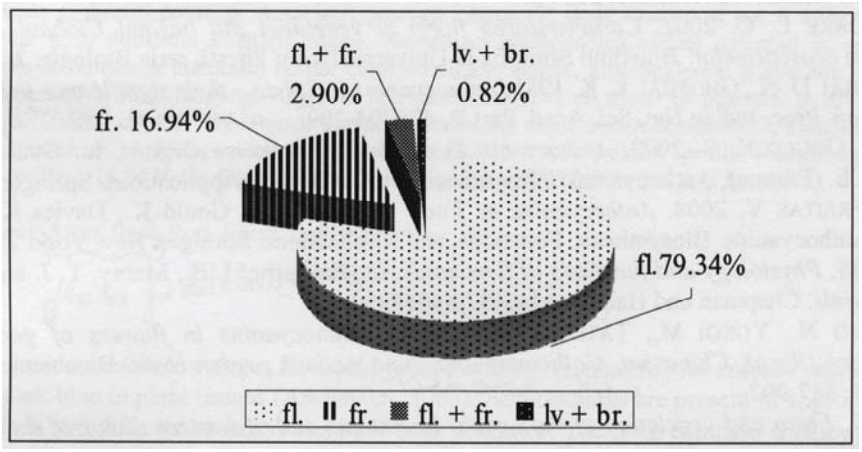

Figure 1. Distribution of anthocyanins in the organs of the identified species (br.-bracts, fl.-flowers, fr.-fruits, lv.-leaves).
Figura 1. Distribuţia antocianilor în organele speciilor identificate (br.-bractee, fl.-flori, fr.-fructe, lv.-frunze).

The anthocyanin distribution in plants is also important in chemotaxonomy. Thus, during a wide survey of flower flavonoids in a variety of sections in the genus *Rosa*, altogether 11 anthocyanins were identified. According to the anthocyanin distribution patterns in the genus, eight groups were identified (MIKANAGI et al., 2000). In the *Brassicaceae* around 45 different anthocyanins have been reported to occur in various species. All anthocyanins are either based on cyanidin or pelargonidin (ANDERSEN & JORDHEIM, 2006). Studies on the distribution pattern of anthocyanins in species of *Salvia* and other *Lamiaceae* have shown that the red, scarlet and pink-colored flower varieties contained pelargonidin, the blue ones delphinidines, and the amethyst- and grape-violet-colored ones were based on cyanidines derivatives (HAQUE et al, 1981). The 3-rhamnoside-5-glucosides of petunidin (71%), delphinidin (12%) and malvidin (9%) have been isolated from the purple-blue flowers of *Vicia villosa* (CATALANO et al., 1998). In orchids, cyanidin 3-oxalylglycosides have previously been reckoned to be remarkable taxonomic markers of certain European genera (*Dactylorhiza*, *Nigritella*, *Orchis* and *Ophrys*) (STRACK et al., 1989).

CONCLUSIONS

In the flora of Argeş county, there have been identified 242 species that can be used to extract anthocyanins. The families with the greatest number of species are: Asteraceae – 27, Lamiaceae – 26, Rosaceae – 21, Fabaceae – 17, Scrophulariaceae – 15, Campanulaceae – 12 and Violaceae – 10. 79.34% of the identified species can be used for the extraction of anthocyanins from flowers (fl.), 16.94 % from fruit (fr.), 2.90% from flowers and fruit, 0.82 % from leaves (lv.) and bracts (br.). Database made will serve to the further study of anthocyanin pigments contained in the organs of various species.

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