

CHEMOTAXONOMIC STUDY ON BULGARIAN SPECIES OF *PEUCEDANUM* L. I.

by

BOGDAN KUZMANOV, NIKOLAJI ANDREEV & VENELINA KOZOVSKA

Abstract

KUZMANOV, B., N. ANDREEV & V. KOZOVSKA (1981). Chemotaxonomic study on bulgarian species of *Peucedanum* L. I. *Actas III Congr. OPTIMA. Anales Jard. Bot. Madrid* 37 (2): 779-788.

Six species of *Peucedanum* (from two sections) native of Bulgaria have been studied for their coumarins and flavonoids (roots, stems, flowers and fruits have been used). Twenty three coumarins and twenty five flavonoid components were found. A chemotaxonomic analysis of the species is made and the systematic position of the balcan endemic *Peucedanum vittijugum* is considered.

Resumen.

KUZMANOV, B., N. ANDREEV & V. KOZOVSKA (1981). Estudios quimiotaxonómicos en especies búlgaras de *Peucedanum* L. I. *Actas III Congr. OPTIMA. Anales Jard. Bot. Madrid* 37 (2): 779-788 (En inglés).

Se estudiaron las cumarinas y flavonoides de seis especies de *Peucedanum* de Bulgaria. Se encontraron veintitrés cumarinas y veinticinco flavonoides. Se hace un análisis quimiotaxonómico de las especies estudiadas y se considera la posición sistemática del endemismo balcánico *Peucedanum vittijugum*.

INTRODUCTION

There are some 120 species of *Peucedanum* L. (fam. *Apiaceae* subfam. *Apioideae* trib. *Peucedaneae*) widespread in Europe, Mediterranean region and South, Western and Central Asia (WILLIS, 1968; HEYWOOD, 1971). In Europe there are 29 species and subspecies (of which 20 are endemics) (TUTIN, 1968) and in Bulgaria 11 (of which 4 are balcan endemics) (KUZMANOV & ANDREEV, 1981). Comparative phytochemical data is available for only 55 species. In 40 of them coumarins have been found, in 27 flavonoids and in 21 other natural products (butenolides, chromones, terpenes, sterols et al.) (HEYWOOD, 1971; CARBONNIER & al., 1977; VALUCKAJA, 1977; STEFANOVIĆ & al. 1978; KERIMOV, 1979).

Coumarins have not been found by LESKOVA (1969) in *Peucedanum*

(*) Institute of Botany, Bulgarian Academy of Sciences, 1113, Sofia. Bulgaria.

coriaceum sect. *Peucedanum* (in roots, stems and fruits) and VALUCKAJA (1977) has not found flavonoids in four species of sect. *Selinoidea* DC. of *Peucedanum*.

During the last ten years *Peucedanum ruthenicum* M. B. and *P. arenarium* W. K. (both subsp. *arenarium* and *neumayeri*) have been intensively studied (mostly coumarins) (BUBEVA-IVANOVA & al., 1969; ZELEVA & al., 1971, 1972, 1976). Many of the isolated substances and especially the coumarins have been used for medical purpose (MUCERJI, 1956; VERMEL & al., 1959; IVANOV & RABEN, 1959; ARORA & al., 1960; HADŽAJI & KUZNEGOVA, 1965- HADŽAJI & al., 1966; ZÉLEVA, 1971). Data for species of *Peucedanum* is given also in NIKONOV & PIMENOV (1968), VALUCKAJA & TJURINA (1974) and VALUCKAJA (1977). Presence of different coumarins has been reported, but not used for chemotaxonomic conclusions and chemosystematics of the genus. NIKONOV & PIMENOV (1968) have investigated seven species of *Peucedanum* and concluded that presence of the furocoumarin Peucedanin can be considered as a chemotaxonomic character. VALUCKAJA & TJURINA (1974) have studied roots and fruits of 12 introduced species of some 4 sections. When cultivated in Novosibirsk, these plants do produce a variety of coumarin derivatives. VALUCKAJA (1977) has studied flavonoids (of overground parts) of 12 species from 2 sections and agrees with the concepts of TIHOMIROV & PIMENOV (1976) that in *Peucedanum* L. «several independent evolutionary lines are united» (*op. c.*: 179).

In this study we have investigated the coumarins and flavonoids of 6 species (from 2 sections, see Table 1) of the bulgarian species of *Peucedanum*.

MATERIALS AND METHODS

Roots, stems, flowers (in full blossom) and ripe fruits were used in order to study coumarins and flavonoids of *Peucedanum* species (see Table 1). All plant materials were collected from natural habitats at appropriate time during a three year period (1976-1978). Five grammes of dried plant material were extracted 4 times with petroleum ether, chloroform and 80 % methanol (1:4 - plant material; solvent). The collected extracts were evaporated under reduced pressure to a volume of 5 ml. For determination of the flavonoids were used: 1. Shinoda test (1 ml of the methanol extracts were evaporated, diluted with 1 ml of water + 1 ml methanol + 3 - 4 mg magnesium + 3 - 4 drops of conc. hydrochloric acid). Colouring of the solutions from pink to red is an indication for presence of flavonoids. 2. Extracts positive to the above reaction were studied by TLC (on DC Fertigplatten Kieselgel 60, 20 × 20, Merck) in two systems: I - for flavonol glucosides, ethylacetate: methyl isobutyl ketone :formic acid :water (5:3:1:1) and II - for flavonols, benzene :methanol :methyl isobutyl ketone (8:2:1). Flavonoid spots on the plates were detected under 5 % alcoholic AlCl₃ and for enhancement of the fluorescence plates were treated with ammonia vapours. The R_f values were determined as average from 5 plates. In order to determine some of the flavonoid spots authentic samples of: Qu-3-ruthinoside (R_f 0,17), Qu-3-galactoside (0,38), Is-3-glucoside (0,47) for the first system and of: Quercetin (R_f 0,16), Isoramnetin

(0,23) and Kaempferol (0,36) for the second system were used. The results are given in Table 5.

Coumarins were determined in chloroform and petroleum ether extracts by TLC (on DC - Fertigplatten Kieselgel - 60 Merck) in two systems, toluene: ethylacetate: benzene: formic acid (5:4:10:1). The coumarin spots on the plates were determined under UV after treatment with 10 % alcoholic KOH and then confirmed with the colour reaction with diazotized sulfanilic acid. Coumarins were observed under UV light as yellow to violet spots. As authentic samples of isoimperatorin (Rf-0,65), peucedanin (0,59), 8-methoxy peucedanin (KOZOVSKA & ZELEVA, 1980), bergapten (0,57), peuruthenicin (officinalin, 0,55), oxypeucedanin (0,47), bergapton (0,37), umbelliferon (0,31) and Oxypeucedanin hydrate (0,13) Rf values were also determined and the results are given in Table 2. On the basis of the values of the flavonoid and coumarin spots found in the different species two coefficients were determined: Pair affinity value - PA (after ELLISON, ALSTON & TURNER, 1962; SOKAL & SNEATH, 1963) and Correlation coefficient - Pi (after JOHNSON & THEIN, 1970) and the results are given Tables 3, 4, 6 and 7.

RESULTS AND DISCUSSION

We have found a variety of coumarins in *Peucedanum officinale*, *P. longifolium* and *P. ruthenicum* (Table 2) and rather poor content in *P. vittjugum*, *P. carvifolia* and *P. oligophyllum*. Some 23 coumarin components were distinguished. Three components: N°8 (Rf = 0,23), N°9 (umbelliferon, Rf = 0,31) and N°18 (Rf = 0,53) are common for all 6 species of the two sections. Five coumarins are common for all four species in sect. *Peucedanum* while these are only 2 for the species in sect. *Palimboidea*. *Peucedanum officinale*, *P. longifolium* and *P. ruthenicum* have 15 of their 23 components in common of which 10 are only in these species (Table 2). The separate species are characterised by: *Peucedanum officinale* by component N° 16 (Rf = 0,50); *P. ruthenicum*, N°21 (Rf = 0,58) and *P. vittjugum*, N°1 (Rf = 0,04) N° 2 (Rf = 0,08), N°3 (Rf = 0,11) and N°12 (Rf = 0,39). According to these the values of RA and Pi of the european species *Peucedanum officinale* and *P. longifolium* point to a great similarity - PA = 94,44 % and Pi = 0,001. *Peucedanum ruthenicum* - an euroasiatic species is somewhat different - it has PA = 78,95 % and Pi = 0,003 with *P. officinale* and PA = 83,33 % and Pi = 0,003 with *P. longifolium*. The fourth species of this section - *Peucedanum vittjugum* which is a balcan endemic clearly separates from the other three. Its similarity indexes vary from PA = 22,73 % to 25,0 % and Pi = from 0,187 to 0,113 with all three species of sect. *Peucedanum*. *Peucedanum vittjugum* is more close to *P. carvifolia* and *P. oligophyllum* of sect. *Palimboidea* having PA = 33,3 - 44,44 % and Pi = 0,014 - 0,047 with both species. The two species of sect. *Palimboidea* - *Peucedanum carvifolia* and *P. oligophyllum* are rather close - PA = 75,0 % and Pi = 0,002 (Table 3 and 4).

In the six species studied 25 different flavonoid components were found in system I and II (Table 5). Nine of the components are common for all 6 species: N°2 (Qu-3-rutinoside, Rf = 0,17), N°6 (Qu-3-galactoside, Rf

= 0,38), N°8 (Isoramethon-3-glucoside, Rf = 0,47) N° 13 (Rf = 0,70), N°14 (Rf = 0,86), N°18 (Rf = 0,00) N°19 (Rf = 0,06), N°20 (Rf = 0,10), N°21 (Quercetin, Rf = 0,16). The three species of sect. *Peucedanum* - *P. officinale*, *P. longifolium* and *P. ruthenicum* have all their components common (the different components are in different quantities in the separate species but this is not considered in this study). The other species of the section - *Peucedanum vittijugum* has 11 components in common with the other three species and PA is 50 % and Pi is 0,329. The same is the relation with the two species of sect. *Palimboidea* - *Peucedanum carvifolia* and *P. oligophyllum* and PA = 50 % and Pi = 0,209 - 0,322 (Table 6 and 7). There is a considerable difference between the species in sect. *Palimboidea* and the respective PA = 68,18 % and Pi = 0,143 are more significant higher than with *P. vittijugum* (Table 6 and 7). It is interesting to point out that *Peucedanum vittijugum* has not the common for *Peucedanum*; Quercetin, Kaempferol and Isoramnetin found in all other studied species, but is the only species with component N°22 (Rf = 0,37) which is not determined as yet.

At present for the genus *Peucedanum* are known: for sect. *Peucedanum* 12 simple coumarins, 18 furanocoumarins (17 linear and 1 angular) and one pyranocoumarin (see CARBONNIER, 1977). Our results agree with this data. For sect. *Palimboidea* there is no data for identified coumarins. PIMENOV (1969) recorded only 0,05 % of total coumarins in *Peucedanum podolicum* (Bess.) Eich. We have found also poor content of coumarins in the species of this section.

Of the flavonoids in *Peucedanum* have been found mostly flavonols - Quercetin, Kaempferol and Isoramnethin along with their glycosides and very rarely the flavons (Luteolin and Apigenine) (HARBORNE, 1967; CARBONNIER, 1977). We have found also the same Quercetine, Kaempferol and Isoramnethin and some of their glycosides but Luteoline and Apigenine.

In section *Peucedanum* three species - *Peucedanum officinale*, *P. longifolium* and *P. ruthenicum* are very similar on their coumarins and flavonoids. This is in correlation with the results of their comparative morphologic and cytotoxic studies (KUZMANOV & ANDREEV, 1981; KUZMANOV, ANDREEV, GEORGIEVA & MITREV, in press).

Peucedanum carvifolia and *P. oligophyllum* are more distinguished both on their coumarins and flavonoids. The species of the two sections are similar in their flavonoid content but coumarins are very poor in sect. *Palimboidea*.

Peucedanum vittijugum is clearly distinguished from the other three species of sect. *Peucedanum* and is somewhat more close to species of sect. *Palimboidea*. It may deserve to be separated in a new section.

Our study shows that coumarins may more easily be used in chemotaxonomic studies in genus *Peucedanum* while flavonoids show a more constant pattern, characteristic rather for sections or the whole genus.

TABLE 1

PHYTOCHEMICALLY STUDIED POPULATIONS OF *PEUCEDANUM*

№ 1	Section and species 2	Locality and voucher № 3
SECT. <i>PEUCEDANUM</i>		
1	<i>Peucedanum officinale</i> L.	Central Stara planina mt. - grassy places near village Gavrilovo, distr. Sliven. 25.8.1976. NA - 7761
2	<i>Peucedanum longifolium</i> Waldst. & Kit.	Struma valley - rocky slopes by river Struma at Kresna. 5.6.1974. NA - 7613
3	<i>Peucedanum ruthenicum</i> M.B.	Region of Sumen - grassy places on the hill «Kabijuska mogila». 5.6.1974. NA - 764
4	<i>Peucedanum vittijugum</i> Boiss. subsp. <i>minutifolium</i> (Jka.) Kuzm. N. Andr.	Rhodopi foothills - the hills «Besaparski» by the peak Elenin. 25.9.1975. NA - 75230
SECT. <i>PALIMBOIDEA</i> BOISS.		
5	<i>Peucedanum carvifolia</i> Vill.	Vitosa region - Ljulin mt., grassy places at «Karleéza». 20.10.1975. NA - 75195.
6	<i>Peucedanum oligophyllum</i> (Griseb.) Vandas subsp. <i>aequiradium</i> (Vel.) Acht.	Pirin mt. - grassy places in Pinus mugus bushes at chalet «Vihren». 19.9.1975. NA - 75105

BIBLIOGRAPHIC REFERENCES

- ARORA, R. T. SESHARDI & N. KRISHNASWAMY (1960). Antiveratrin activity of coumarins and its derivatives compounds. *Arch. Int. Pharm. Ther.* 124.
- BUBEVA-IVANOVA, L., A. ZELEVA & P. SAVCEV (1969). O kumarinovom i flavonoidnom sostave *Peucedanum ruthenicum*. *Khim. prirod. Soedin.* 6:594-597.
- CARBONNIER, J., O. FATIANOFF & D. MOLHO (1978). Phytochimie comparée des taxons rattaches a la tribu des Peucedaneae. *Contr. Pluridisc. System. (Actes 2 Symp. Intern. Umbell.)* 387-513, Perpignan.
- HADZAJI, L. & V. KUZNECOVA (1965). Pro vypevoroztutirujuci dyju atamantinu. Povydomlenija I. *Farm. Zurn.* 4:47.
- HADZAJI, J., G. OBOLONCEVA & A. PROKOPENKO (1966). O svjasi mezdu strukturoj i spazmoliticeskoj aktivnostju v rjadu proizvodnyh kumarina i furokumarina. *Pharmakol. Toksikol.* 2:156-163.

- ELLISON, W., R. ALSTON & B. TURNER (1962). Methods of presentation of crude biochemical data for systematic purposes, with particular reference to genus *Bahia* (Compositae). *Amer. J. Bot.* 49:599-604.
- HARBORNE, Y. (1967). *Comparative biochemistry of the flavonoids*. Academic Press. London.
- HEYWOOD, V. (Ed.) (1971). The biology and chemistry of the Umbelliferae. *Bot. J. Linn. Soc.* 64, Suppl. I:1-453.
- IVANOV, P. & A. RABEN (1959). Opyt lecenija vitiligo meladininom. In: *Sborn. Nauc. Rab. Lepr. Derm. Rost. Med. Pist.* 12.
- JOHNSON, B. & M. THEIN (1970). Assesement of evolutionary affinities in the *Gossypium* by protein electrophoresis. *Amer. J. Bot.* 57:1081-1092.
- KERIMOV, Kh. (1979). Furocoumarins of *Peucedanum ruthenicum*. *Khim. prir. soed.* 1:93-95.
- KOZOVSKA, V. & A. ZELEVA (1980). Natural coumarins X. A new furocoumarin, 8-methoxy peucedanin from the roots of *Peucedanum ruthenicum* M. B. *Planta medica*.
- KUZMANOV, B. & N. ANDREEV (1981). Genus *Peucedanum* L. In: *Flora Rep. Pop. Bulg.* 8.
- KUZMANOV, B., N. ANDREEV, S. GEORGIEVA & A. MITREV (in press). Karyological study on *Peucedanum* L. in Bulgaria. *Phytology*.
- LESCOVA, E. & A. ANANICEV (1969). The content of coumarin derivatives in some species of Umbelliferae cultivated in the Moscou region. *Rast. Res.* 5 (4):565-570.
- MUCERJI, B. (1956). Psoralen and other indigenous drug in leucoderma. *J. Sci. Industr. Res.* 15 (A):1.
- NICONOV, G. & M. PIMENOV (1968). *Khim. prir. Soedin.* 4:48.
- PIMENOV, M., V. VANDYSHEV & G. NICONOV (1969). *Trud VILAR* 15:126.
- SOKAL, R. & P. SNEATH (1963). *Principles of numerical taxonomy*. Freeman, Francisco.
- STEFANOVIUC, M., S. MLADENOVIC & M. DJERANOVIC (1978). Stereoisometric Pyranocoumarins (Khellactone Esters), Pyrano-and Furanochromones from *Peucedanum austriacum* (Jacq.) Koch. *11 th IUPAC Symp. Varna* 2:173.
- TIHOMIROV, V. & M. PIMENOV (1976). Rekonstrukcija filogenii zonticnyh: puti i metody sovremenogo issledovanija. In: *Mater. V. Mosk. Sov. Filog. Rast.*:178-180.
- TUTIN, T. (1968). Genus *Peucedanum* L. In: *Flora Europaea* 2:360-364.
- VALUCKAJA, A. (1977). Sravnitelnoe izucenie flavonoidov roda *Peucedanum*. *Izv. Sibirsk. Ot-del. AN URSS, ser. Biol.* 15 (3):285.
- VALUCKAJA, A. & E. TJURINA (1974). Biologiceski aktivnye soedinenija rastenii Sibirskoji flory. *Novosibirski, Nauka*, 43 p.
- VERMEL, E. & S. KRUGLJAK-SYRKINA (1959). O deistvii peucedanina i fosforamidov na peryvanie opuholi zivornuyh. *Vopr. Onkol.* 5 (7).
- WILLIS, J. (1968). *A dictionary of the flowering plants and ferns*. Cambr. Univ. Press. Cambridge.
- ŽELEVA, A., L. BUBEVA-IVANOVA & S. SPASOV (1971). Natural coumarins. III. On the structure of Peuarenarine, a new coumarin from *Peucedanum arenarium* W. K. *Zeitschr. Naturforsch.* 26 (2):113-115.
- ŽELEVA, A. P. MANOLOV & L. BUBEVA-IVANOVA (1971). Phitohimicno i farmakologijno proucvane na kumarinoviija sastav na *Peucedanum arenarium* W. K. *Pharmacija (Sofija)* 21 (6):31-34.
- ŽELEVA, A., T. SOINE & L. BUBEVA-IVANOVA (1972). Natural coumarine. V. Isolation of xanthalin and a new pyranocoumarin, Peuarenine from *Peucedanum arenarium* W. K. *J. Pharm. Sci.* 61 (10):1643-1644.
- ŽELEVA, A., M. MAHANDRU & L. BUBEVA-IVANOVA (1976). Natural coumarins. VIII. Four new coumarins from the roots of *Peucedanum arenarium* W. K. *Phytoch* 15:209-214.

TABLE 2
 COUMARIN DERIVATIVES IN THE SPECIES OF *PEUCEDANUM* L. (DATA FROM TLC)

Taxon	Investigate organs	R _F values																						
		0.04	0.08	0.11	0.13	0.15	0.22	0.25	0.28	0.31	0.33	0.37	0.39	0.41	0.44	0.47	0.50	0.51	0.53	0.55	0.57	0.58	0.59	0.65
1.1. <i>P. officinale</i> L.	roots	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	stems	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	leaves	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	flowers	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	fruits	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
1.2. <i>P. longifolium</i> W. K.	roots																							
	stems																							
	leaves	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	flowers	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	fruits	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
1.3. <i>R. rutheranicum</i> M. B.	roots	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	stems	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	leaves	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	flowers	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	fruits	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
1.4. <i>P. vitifolium</i> Boiss.	roots																							
	stems																							
	leaves																							
	flowers	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	fruits	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
2.1.(5) <i>P. carisifolia</i> Vill.	roots																							
	stems																							
	leaves																							
	flowers	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	fruits	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
2.2.(6) <i>P. oligophyllum</i> (Grisb.) Vandas	roots																							
	stems																							
	leaves																							
	flowers	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
	fruits	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

Authentic sample: N.° 4 - RF = 0.13 - Oxypeucedanin hydrate; N.° 9 - 0.31 - Umbelliferon; N.° 11 - 0.37 - Bergapton; N.° 15 - 0.47 - Oxypeucedanin; N.° 19 - 0.55 - Peurautenicin (Officialin); N.° 21 - 0.58 - 8-metoxo - peucedanin; N.° 22 - 0.59 - Peucedanin; N.° 23 - 0.65 - Isomperatorin.

TABLE 3
 PAIRED AFFINITY (PA) VALUES AS DETERMINED FOR 6 SPECIES OF *PEUCEDANUM* - COUMARINS

Taxon	<i>P. officinale</i>	<i>P. longifolium</i>	<i>P. ruthenicum</i>	<i>P. vittjugum</i>	<i>P. carvifolia</i>	<i>P. oligophyllum</i>
<i>P. officinale</i>	100					
<i>P. longifolia</i>	94,44	100				
<i>P. ruthenicum</i>	78,95	83,33	100			
<i>P. vittjugum</i>	22,73	23,80	25,00	100		
<i>P. carvifolia</i>	15,79	17,68	18,75	33,33	100	
<i>P. oligophyllum</i>	22,22	23,52	25,00	44,44	75,00	100

TABLE 4
 CORRELATION COEFFICIENTS (PI) AS DETERMINED FOR 6 SPECIES OF *PEUCEDANUM* - COUMARINS

Taxon	<i>P. officinale</i>	<i>P. longifolium</i>	<i>P. ruthenicum</i>	<i>P. vittjugum</i>	<i>P. carvifolia</i>	<i>P. oligophyllum</i>
<i>P. officinale</i>	0					
<i>P. longifolium</i>	0,0010104	0				
<i>P. ruthenicum</i>	0,016622	0,0033284	0			
<i>P. vittjugum</i>	0,1572706	0,1135843	0,1870801	0		
<i>P. carvifolia</i>	0,4607556	0,3839638	0,3162055	0,0474308	0	
<i>P. oligophyllum</i>	0,3455674	0,2687747	0,2055335	0,0142292	0,0022786	0

TABLE 5
FLAVONOIDS IN THE SPECIES OF *PEUCEDANUM* L. (DATA FROM TLC)

Taxon	investigate organs	Rf values (X100) in system I										Rf values (X1000) in system II															
		0.14	0.17	0.19	0.23	0.31	0.38	0.42	0.47	0.52	0.57	0.59	0.65	0.70	0.86	0.88	0.96	0.98	0.00	0.06	0.10	0.16	0.23	0.27	0.36	0.37	
1.1. <i>P. officinale</i> L.	stems						+	+																			
	leaves						+	+																			
	flowers	+	+	+	+	+	+	+																			
	g.fruits	+	+	+	+	+	+	+																			
	r.fruits	+	+	+	+	+	+	+																			
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
1.2. <i>P. longifolium</i> W.K.	stems																										
	leaves																										
	flowers	+	+	+	+	+	+	+																			
	g.fruits	+	+	+	+	+	+	+																			
	r.fruits	+	+	+	+	+	+	+																			
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
1.3. <i>P. rubricum</i> M.B.	stems																										
	leaves																										
	flowers	+	+	+	+	+	+	+																			
	g.fruits	+	+	+	+	+	+	+																			
	r.fruits	+	+	+	+	+	+	+																			
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
1.4. <i>P. nitidum</i> Boiss.	stems																										
	leaves																										
	flowers	+	+	+	+	+	+	+																			
	g.fruits	+	+	+	+	+	+	+																			
	r.fruits	+	+	+	+	+	+	+																			
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
2.1. (5) <i>P. carajóla</i> Vill.	stems																										
	leaves																										
	flowers	+	+	+	+	+	+	+																			
	g.fruits	+	+	+	+	+	+	+																			
	r.fruits	+	+	+	+	+	+	+																			
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
2.2. (6) <i>P. oligophyllum</i> (Griseb.) Vandas	stems																										
	leaves																										
	flowers	+	+	+	+	+	+	+																			
	g.fruits	+	+	+	+	+	+	+																			
	r.fruits	+	+	+	+	+	+	+																			
Total	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	

Authentic samples: N° 2 - Rf = 0.17 - Qu - 3 - Rutinoside; N° 6 - 0.38 - Qu - 3 - Galactosidase; N° 8 - 0.47 - Ia - 3 - Glucosidase; N° 21 - Rf = 0.16 - Quercetin; N° 22 - 0.23 - Isoamnetin; N° 24 - 0.36 - Kaempferol.

TABLE 6
 PAIRED AFFINITY (PA) VALUES AS DETERMINED FOR 6 SPECIES OF *PEUCEDANUM*-FLAVONOIDS

Taxon	<i>P. officinale</i>	<i>P. longifolium</i>	<i>P. ruthenicum</i>	<i>P. vittijugum</i>	<i>P. carviifolia</i>	<i>P. oligophyllum</i>
<i>P. officinale</i>	100					
<i>P. longifolium</i>	100	100				
<i>P. ruthenicum</i>	100	100	100			
<i>P. vittijugum</i>	50	50	50	100	•	
<i>P. carviifolia</i>	66,66	66,66	66,66	50	100	
<i>P. oligophyllum</i>	76,19	76,19	76,19	50	68,18	100

TABLE 7
 CORRELATION COEFFICIENTS (PI) OF *PEUCEDANUM* AS DETERMINED FOR 6 SPECIES-FLAVONOIDS

Taxon	<i>P. officinale</i>	<i>P. longifolium</i>	<i>P. ruthenicum</i>	<i>P. vittijugum</i>	<i>P. carviifolia</i>	<i>P. oligophyllum</i>
<i>P. officinale</i>	0					
<i>P. longifolium</i>	0,0000183	0				
<i>P. ruthenicum</i>	0,0000183	0,0000183	0			
<i>P. vittijugum</i>	0,3229813	0,3229813	0,3229813	0		
<i>P. carviifolia</i>	0,455957	0,455957	0,455957	0,3229813	0	
<i>P. oligophyllum</i>	0,0223978	0,0223978	0,023978	0,2094279	0,1433465	0