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CHEMICAL COMPOSITION AND PHARMACOLOGICAL PROPERTIES OF PLANTS OF THE GENUS *Stachys*

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This review gives information of the distribution of alkaloids, carbohydrates, lipids, essential oils, diterpenoids, iridoids, flavonoids, and pigments in plants of the genus Stachys L. (fam. Lamiaceae). *It has been shown that the genus* Stachys *is of interest for researchers as a source of biologically active substances of various classes which are responsible for the broad spectrum of pharmaceutical-therapeutic action of plants of this genus and drugs prepared from them. Characteristic for these plants is a low content of saturated fatty acids in the seed lipids and, in the epigeal part, of essential oils, an accumulation of iridoids of the aucubin type, and the fact that all the flavone derivatives present have a large number of substituents in ring A of the flavone nucleus. This indicates the antiquity and phylogenetic primitiveness of the* Stachys *genus. The results of chemical and pharmacological-therapeutic studies of plants of the* Stachys *genus growing on the territory of the former USSR are given. Literature sources up to and including 1991 have been used.*

The world flora includes 275 species of the genus *Stachys* L. (fam. Lamiaceae) [1]. In the flora of the USSR [2], 50 species have been described and have been separated morphologically into 3 sections. The systematics of the *Stachys* genus is difficult, since it is characterized by a high species variability and ecological plasticity. Some workers regard ecoforms of *Stachys* as individual species [3, 4] Modern systematics distinguishes only 37 species of the genus *Stachys* in the flora of the USSR [5]. The largest number of species (more than half) grows in the Caucasus [2, 6]. The validity of the combination or separation of individual species has recently been confirmed by chemosystematic investigations [7].

Of the 37 species of *Stachys* L. in the USSR flora [5], 12 find use in folk medicine [8]. They possess antiphlogistic, cholagogic, sedative, hypotensive, wound-healing, hemostatic, and other properties [9-11]; they are used for coughs and in cases of throat pains, diseases of kidneys, of the stomach, and also in cases of indurated tumors [12-18]. The genus name *Stachys*, adopted in in the Slavonic languages as *chistets* [cleanser; woundwort] shows the main use of species of this genus — for the treatment of skin diseases [16-21].

Stachys species are used in the folk medicine of Bulgaria [22, 23], Germany [1], Afghanistan [24], and China [15]. The species *S. recta* has been included in the pharmacopias of France and Mexico and is used in homeopathy [1]. The species *S. sylvatica*, *S. palustris*, *S. recta*, and *S. annua* are not eaten by cattle and are regarded as poisonous [21, 25-29].

The diverse uses of *Stachys* species can be explained by the different pharmacological properties of the biologically active substances contained in them.

The foundation of the chemical investigation of the genus *Stachys* L. was laid by studies on plant alkaloids and carbohydrates that appeared at the end of the 19th century [30, 31]. The most widespread alkaloid, which is used in medicine, is stachydrine; this has been detected in many representatives of this genus [31]. For species of the genus *Stachys* L. growing in the territory of the USSR, the presence of stachydrine has been established in *S. baicalensis* [12, 32], *S. palustris* — 0.62% [12], *S. recta* [13, 15], *S. betoniciflora* — 0.49-2.42% [3, 15, 33], and *S. sylvatica* [34]. Other bases detected in plants of the genus *Stachys* L. are choline, betaine, allantoin, and turicine [25, 26, 34].

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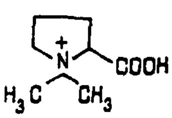
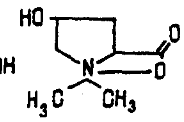

Stachydrine


Turiaine

Quaternary bases of betaine series have been found in *S. sylvatica* [36-38], *S. betoniciflora* [13], and *S. palustris* [12].

Sugars have been detected in roots and rhizomes of the genus *Stachys* L. Stachyose ($Gal_p(\alpha 1 \rightarrow 6)Gal_p(\alpha 1 \rightarrow 6)Glu_p(\alpha 1 \rightarrow \beta 2)Fru_f$), which is specific for the vegetative organs of these plants is present in fresh roots of *S. tuberifera* (syn. *affinis*) to an amount of 17% [1].

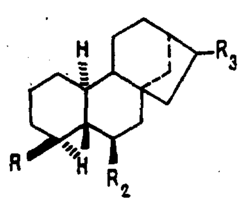
A large amount of starch has been detected in the roots and tubers of *S. palustris* [27, 39], which is regarded as edible. Carbohydrates have been reported for *S. sylvatica* [13, 34], *S. balansae* and *S. lanata* [14, 32, 40].

The seeds of the species *S. balansae*, *S. lanata*, *S. sylvatica*, *S. annua*, *S. palustris*, *S. betoniciflora* contain from 24 to 44% of fatty oils [9, 26-28, 32, 35, 40-42].

The fatty oils of seeds of the genus *Stachys* L. contain triacylglycerols derived from palmitic, stearic, oleic, linoleic, and linolenic acids [41, 42]. Triacylglycerols of linoleic acid — 60-70% (of the total) — and of oleic acid — 20-30% — predominate in the fatty oils of the *Stachys* species studied, while the amount of triacylglycerols mainly containing saturated fatty acid residues predominated — 5 to 10%.

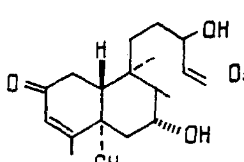
The amount of essential oils in the epigeal parts of some species of *Stachys* L. gathered in the flowering period ranges from 0.008 to 0.83% [13, 43, 44]. *S. pubescens*, *S. fruticulosa*, *S. annua*, and *S. inflata* produce essential oils with a lemon odor [9, 27, 43]. Only certain constants have been given for the essential oils from the herbage of *S. lanata* and *S. turcomanica* [14, 27, 40, 43, 44]. The terpenoid composition of the essential oils has not been studied except for the essential oils of *S. germanica* and *S. annua*. Thus, the essential oil of *S. germanica* contains the aliphatic monoterpene hydrocarbons myrcene and *cis*-ocimene, the sesquiterpene aliphatic hydrocarbon *trans*-β-farnesene, the monoterpenes limonene, α-terpineol, and cineole, the bicyclic monoterpenes sabinene and β-pinene, and the aromatic compound *para*-cymene, and also the monocyclic sesquiterpene germacrene [45]. Bicyclic sesquiterpene hydrocarbons of the type of cadalene and a substance of phenolic nature have been detected in the essential oil of *S. annua* [27]. The essential oil of *S. betoniciflora* gives a positive reaction for aldehydes [13, 43]. The oil of *S. sylvatica* is blue [25, 34]. *S. atherocalix*, *S. turcestanica*, *S. palustris*, *S. baicalensis*, *S. iberica*, and *S. lavandulaefolia* contain small amounts of essential oils [43].

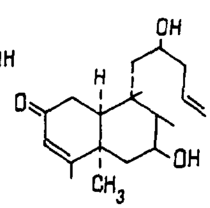
The structure of kaurane diterpenoids, which are rarely found in the family Lamiaceae, has been studied. Stachysic acid, 6-hydroxykaurene, and 6,18-dihydroxykaurene have been detected in *S. sylvatica* [46].

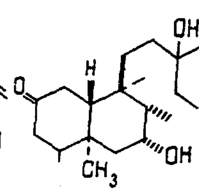


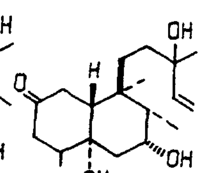
1. R=CH_3; R_2=OH; R_3=—CH_3. 6-Hydroxy-(-)-kaurene
2. R=CH_2OH; R_2=OH; R_3=—CH_3. 6-18-Dihydroxy-(-)-kaurene
3. R=COOH; R_2=OAc; R_3= =CH_2. Stachylic acid

The bitter diterpene bicyclic ketodiols stachysolone, stachylone, stachone, and annuanone, which are labdane derivatives, have been found in *S. annua* [46-50].


Stachysolone


Annuanone


Stachone


Stachylone

Bitter substances of unestablished structure have been detected in *S. balansae* and *S. lanata* [14, 40].

In 1952, Trim and Hill [51] detected iridoids of the aucubin series in extracts from the herbage of *S. sylvatica*, *S. palustris*, and *S. tuberifera* [51]. Later, the presence of iridoids in other species of *Stachys* L. was established by paper chromatography and by the isolation of individual substances [52-57]. The most characteristic iridoids for the genus proved to be harpagide, 8-acetylharpagide, reptoside, deacetylreptoside, ajugol, and ajugoside [7, 55, 56]. Iridoids have been detected

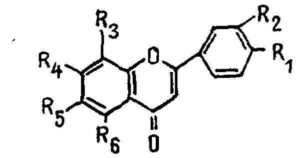
TABLE 1. Information on the Presence of Iridoids in some Species of the Genus *Stachys* L. (literature source)

The *Stachys* L.	Harpagide	Harpagide 8-acetate	Ajugol	Ajugoside	Lamiol and lamiol acetate
S. lavandulaefolia	41, 58	41, 58	41	41	
S. betoniciflora	7, 69	7, 69			
S. sylvatica	41, 58	41, 58			
S. grossheimi	58	41, 58			
S. germanica		41			
S. balansae		41	41	41	
S. inflata	41	41, 58	41		
S. iberica	41, 58	41, 58	41	41	
S. atherocalyx	41, 58	41, 58			
S. spectabilis	41, 58	41, 58		41	
S. fruticulosa	41, 58	41, 58			
S. hirta					33

TABLE 2. Cinnamic Acid Derivatives of Species of the Genus *Stachys* L. (literature source)

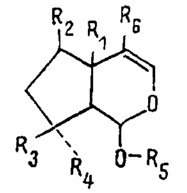
Acid	S. palustris	S. betoni-ciflora	S. baicalensis	S. atherocalyx
para-Coumaric				61
Caffeic	48, 59	71	70	61
1-Caffeylquinic	48	71		
4-Caffeylquinic	48, 59	71		
Chlorogenic	48, 59	71	70	
cis-Chlorogenic				61
trans-Ch овая				61
Neochlorogenic	70, 72	71	70	61
Cryptochlorogenic	70, 72			
Depside of caffeic and quinic acids		71		

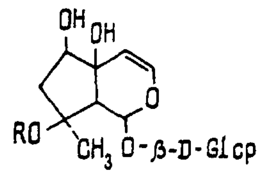
TABLE 3. Distribution of Flavonoids in Plants of the Genus *Stachys* L



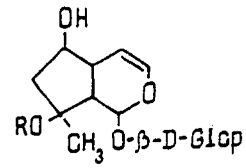
Name	Structure	Name of the plant	Literature
1. 4′,7-Dimethoxy-apigenin	R_1=OCH$_3$; R_4=OCH$_3$; R_6=OH	S. betoniciflora	[52, 74]
2. Neglectin	R_4=OCH$_3$; R_5=O-acylglucobioside R_6=OH	S. neglecta	[75]
3. Neglectein	R_4=OCH$_3$; R_5=OH; R_6=OH	S. neglecta	[75]
4. Palustrinoside	R_4=OCH$_3$; R_5=OH; R_6=*β-D*-Glc$_p$-*β-D*-Glc$_p$	S. palustris	[59]
5. Palustrin	R_4=OCH$_3$; R_5=OH; R_6=O -GlcA- Glc OOCAr	S. palustris	[59]
6. Stachyflaside	R_1=OH; R_4=O-*β-D*-Glc$_p$-2″-O-*β-D*-Man$_p$; R_5=OH; R_6=OH	S. annua, S. spectabilis, S. inflata, S. atherocalyx	[67, 76, 77]
7. 4′-Methoxy-scutellarein	R_1=OCH$_3$; R_4=OH; R_5=OH; R_6=OH	S. palustris, S. annua	[7, 78, 79]
8. Stachannin	R_1=OCH$_3$; R_4=O-*β-D*-Glc$_p$; R_5=OH	S. annua	[80]
9. Stachannoside	R_1=OCH$_3$; R_4=O-*β-D*-Glc$_p$-2″-O-*β-D*-Man$_p$; R_5=OH; R_6=OH	S. annua	[77, 80]
10. Stachannoaci-side	R_1=OH; R_4=O-*β-D*-Glc$_p$-2″-O-*β-D*-Man$_p$; R_5=OH; R_6=OH	S. annua	[81]
11. Acistachybio-side	R_1=O-*β*-D-Glc$_p$-2″-O-*β*-Man$_p$ + ***para*-coumaric acid**; R_3=OH; R_4=OCH$_3$; R_5=OH; R_6=OH	S. annua	[79]
12. Isostachyfla-side	R_1=O-*β-D*-Glc$_p$-2″-O-*β-D*-Man, R_3=OH; R_4=OH; R_6=OH	S. inflata, S. spectabilis	[66, 67]
13. Acetylpalusta-side	R_1=OH R_3=OH; R_4=O-*β-D* Gal$_p$ O-*β*-*D*-Glc$_p$-OAc; R_6=OH	S. palustris	[82]
14. 4′-Methoxyiso-scutellarin	R_1=OCH$_3$; R_3=OH, R_4=OH; R_6=OH	S. inflata	[66]
15. Spectabifla-side	R_1=OH; R_2=OCH$_3$; R_4=O-*β-D*-Glc$_p$ 2″-O-*β-D*-Man$_p$	S. atherocalyx, S. spectabilis	[67, 69]
16. Acetylspecta-biflaside	R_1=OH; R_2=OCH$_3$, R_3=OH, R_4=O-*β*-*D*-Glc$_p$-2″-*β-D*-Man$_p$-O-Ac; R_6=OH	S. atherocalyx	[69]
17. Diacetylspecta-biflaside	R_1=OH; R_2=OCH$_3$, R_3=OH; R_4=O-*β*-*D*-Glc$_p$-2″-O-*β-D*-Man$_p$-di-O-Ac, R_6=OH	S. atherocalyx	[83]
18. Luteolin	R_1=OH, R_2=OH, R_4=OH; R_6=OH	S. palustris	[illegible]
19. Orientin	R_1=OH; R_2=OH; R_3=*β-D*-Glc$_p$, R_4=OH; R_6=OH	S. betoniciflora	[52, 62, 84]
20. Unestablished	Complex of palustrinoside with caffeic and chlorogenic acids	S. palustris	[59]
21. Unestablished	Complex of palustrin with caffeic and chlorogenic acids	S. palustris	[59]

in species of the *Eriostachys*, *Stachyotipus*, and *Olivisia* sections [7, 58]. The iridoid composition characterizes the heterogeneity of the section *Stachyotipus* and confirms the independence of the genus *Betonica* L. [7]. The lamiol and acetyllamiol detected in *S. hirta* confirmed its closeness to species of the *Lamium* section of the *Stachys* genus (Table 1). Iridoids of unestablished structure have been detected in *S. annua* [53].

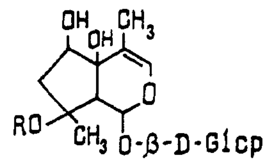




R = H harpagide
R = COCH$_3$ 8- Ajugol 8-acetate



R = H ajugol
R = COCH$_3$ ajugoside



R = H lamiol
R = COCH$_3$ lamioside

1. R_1=OH; R_2=OH; R_3=OH; R_4=CH_3; R_5=β-D-Glc$_p$. Harpagide
2. R_1=OH; R_2=OH; R_3=OAc; R_4=CH_3; R_5=β-D-Glc$_p$. 8-Acetate harpagide
3. R_1=H; R_2=OH; R_3=OH; R_4=CH_3; R_5=β-D-Glc$_p$ Ajugol
4. R_1=H; R_2=OH; R_3=OAc; R_4=CH_3; R_5=β-D-Glc$_p$. Ajugoside
5. R_1=OH; R_2=OH; R_3=OH; R_4=CH_3; R_5=β-D-Glc$_p$; R_6=CH_3. Lamiol
6. R_1=OH; R_2=OH; R_3=OAc; R_4=CH_3; R_5=β-D-Gl$_p$; R_6=CH_3. Lamioside

Stachys species do not contain the rosmarinic acid that is widely distributed among many representatives of the family Lamiaceae, but esters of quinic and caffeic acids have been detected [1], and so have caffeic, *p*-coumaric, and quinic acids, among which chlorogenic and cryptochlorogenic acids predominate [33, 59-63, 89]. Information on the presence of cinnamic acid derivatives in some *Stachys* species is given in Table 2.

The presence of flavonoids is characteristic for the *Stachys* genus [64]. They have various structures. Apigenin and luteolin derivatives are found mainly in the petals [61], and scutellarein, isoscutellarein, and baicalein derivatives in the herbage and roots [7, 65]. A feature of the flavonol glycosides is the presence of a methoxy group in ring *B* and the fact that the carbohydrate component is usually attached in the C-7 position and is represented by glucomannose and, in biosides, by *D*-mannose, and *D*-allose [65-67], while the carbohydrate moieties of the glycosides are not infrequently acylated or esterified by phenolcarboxylic acids [68, 71, 73]. The structures of the flavonoids isolated from plants of the genus *Stachys* L. are given in Table 3.

Flavonoids of unestablished structure have been noted for *S. recta*, and anthocyanins have been observed so far only in flowers of *S. betoniciflora* and *S. baicalensis* [1, 13, 58]. The quantitative content of the sum of the flavonoids in different species of *Stachys L.* fluctuates from 0.6 to 2.48% [12]. Encountered rather frequently, flavonols can be used as a chemosystematic index for assessment of taxons, but only with the limits of a section [7, 61, 85] and not within the entire genus as a whole. The flavonoid composition suggests in particular heterogeneity of the *Eriostachys* section [7, 85].

Tanning substances (up to 5%) are present in *S. sylvatica*, *S. palustris*, and *S. lanata* [13, 14, 34, 39]. In *S. baicalensis*, tanning substances are represesnted by condensed compounds [12]. The presence of the hydroxycoumarin umbelliferone has been established in *S. baicalensis* and *S. palustris*.

Of other compounds, saponins the nature of which has not yet been established have been detected in *Stachys* species [14, 15, 38, 86, 87]. The saponin content of *S. annua* amounts to 0.51% [88]. Of triterpene compounds, β-sitosterol, α-amyrin and β-amyrin [89] and, in *S. palustris*, 0.37% of ursolic acid have been detected [12].

Ascorbic acid is present in the herbage of *S. betoniciflora* — 135 mg% [13] — and in *S. palustris* — 46.2 mg% [12] — and also in *S. sylvatica*, *S. balansae*, *S. lanata*, and *S. baicalensis* [9, 12-14, 32, 90]. The content of organic acids (calculated as citric acid), amounts to 2.1% [12, 14, 32, 34]. Oxalic, citric, tartaric, malic, and succinic acids have been detected in the herbage of *S. palustris* and *S. baicalensis*; the composition of the acids detected has not been identified in the cases of *S. sylvativa*, *S. baicalensis*, and *S. lanata* [14, 34].

The amount of resinous substances in the species *S. sylvatica*, *S. balansae*, *S. baicalensis*, and *S. lanata* ranges from 0.62 to 3.55% [12-14, 32, 39]. Vitamin K has been detected for *S. lanata* [34]. The presence of the pigments β-carotene and α-chlorophyll has been established in *S. betoniciflora* [35].

On generalizing the results of the study of the chemical compositions of plants of the genus *Stachys* L., it may be observed that a low content of saturated fatty acids is characteristic for the fatty oil of the seeds [35, 41], and also for the essential oils in the epigeal part (about 1%), with an accumulation of iridoids of the aucubin type and the presence of flavone derivatives only with a high number of substitutions in ring *A* of the flavone nucleus (Table 3) [7, 64]. All this indicates an antiquity and phylogenetic primitiveness of the *Stachys* genus, which is confirmed by the characteristic trisulcate pollen [1, 91].

Pharmacological and clinical trials have shown the valuable properties of many *Stachys* species. Basing himself on a knowledge of folk medicine, N. P. Subbotin [92] was the first to investigate the influence of *S. sylvatica* on the contractile function of the uterus. He established that the use of an extract of *S. sylvatica* (1:10) caused a contraction of the uterus of various laboratory animals. On repeated administration, an increase in sensitivity to the drug was observed. Subsequently [93], various medicinal forms from *S. sylvatica* (10% decoction, 1:1 liquid extracts in 70% ethanol, dry concentrates prepared from the decoction), were studied from all aspects. Clinical trials showed that on being taken internally the decoction causes an increase in tonus and strengthens the contraction of the rabbit uterus without affecting the rate of clotting of the blood and is nontoxic. Later trials showed that the effect of the liquid extract of *S. sylvatica* is not inferior to that of an ergot extract [94]. Its action is similar to that of ergotoxin, and this has permitted *S. sylvatica* to be recommended for use in obstetric-gynecological practice during the postnatal period (maternal hemorrhage, atonia of the uterus and its involution), and also in meno- and metrorrhagias [94, 95].

The action of a tincture and extract of *S. betoniciflora* has been studied in even greater detail. They cause an increase in the tonus of the uterus and strengthen its contraction and they also possess a hemostatic action [96, 97] that is not inferior to that of ergot preparations [36, 96-100].

It has been established that a tincture of *S. sylvatica* raises the arterial pressure in cats. The tincture possesses a sedative action on the CNS and exhibits a positive ionotropic action on the heart, increasing the strength of cardiac contractions without having an appreciable effect on its rhythm [95]. On internal use it also possesses hypotensive action [14]. Liquid and alcoholic extracts of *S. lanata* and *S. balansae* have been recommended for the treatment of hypotonic disease and cardiac neuroses [14, 32, 40].

A further pharmacological study of the polyphenolic compounds of a number of *Stachys* species that was then undertaken proved to be promising. The cholagogic properties of the total flavonoid preparations "Stakhiren" and "Stakhiglen" from *S. annua* and *S. recta* were investigated. In experiments on dogs, both preparations stimulated the secretion of bile. With an increase in the total amount of bile, its chemical composition changed: the concentration of bile acids and of bilirubin decreased, while the cholesterol level did not change appreciably and the amount of cholates increased. This permits them to be grouped with true cholagogic agents having a medium degree of activity [101-103].

"Stakhiglen" has also been tested for the treatment of chronic gastritis. It was established that it has a favorable influence on the secretory action of the stomach (it increases the amount of pepsin and of gastromucoproteins, and the amount of neuropepsinogen in urine), and also improves the state of the hepatobiliary system [104].

A cholagogic action has also been found for the preparation "Stakhostin" containing the total polyphenolic compounds from *S. atherocalyx* [65, 105]. The choleretic activity of the above-mentioned preparations (Stakhiren, Stakhiglen, Stakhostin), and also of a preparation obtained from *S. germanica*, is favorably supplemented by their antiphlogistic activity [106, 107]. In combination with other agents, Stakhiren has proved to be effective in the treatment of toxoplasmosis [108].

The preparation "Palustakhin" from *S. palustris* possesses a hepatoantitoxic action [109].

A preparation from *S. inflata*, containing the total iridoids, has proved effective as an antiphogistic and cholagogic agent [110, 111].

It is known that the choleretic action of many medicinal plants is due to the presence of flavonoids in them [112]. Iridoids and flavonoids are known as active antiphlogistic agents of plant origin [52, 61, 107]. All this agrees well with the biological activity of the substances (flavonoids, iridoids, polyphenolic acids) isolated from plants of the *Stachys* genus. The hemostatic action of species of this genus is also due to the presence of iridoids, flavonoids, and nitrogenous bases [9, 52].

Analysis of literature information shows that the degrees to which various species of *Stachys* have been studied are dissimilar, and the majority of species have undergone little investigation. The main groups of biologically active substances of the *Stachys* genus that have been found are as follows: nitrogenous bases of betaine type, oligosaccharides, cinnamic acid derivatives, coumarins, flavonoids, organic acids, fatty and essential oils, iridoids, and diterpene and triterpene compounds, and also vitamins, resins, and other substances.

Pharmacological and clinical trials of some *Stachys* species have shown that they are promising for obtaining preparations with uterine, chemostatic, hypotensive, sedative, cholagogic, and antiphlogistic effects.

REFERENCES

1. O. I. Kostyuchenko, Rast. Res., **19**, No. 3, 407 (1983).
2. O. É. Knorring, Flora of the USSR [in Russian], Izd. Akad. Nauk SSSR, Moscow–Leningrad, Vol. 21 (1954), p. 200.
3. T. G. Derviz-Sokolova, Byul. MOIP [Moskovskoe Obshchestvo Ispytatelei Prirody], Otd. Biol. Nauk, **80**, No. 3, 85 (1975).
4. T. G. Derviz-Sololova, "Notes on some species of the genus *Stachys* in the European part of the USSR" , Byul. MOIP, Otd. Biol. Nauk, **81**, No. 2, 146 (1976).
5. S. K. Cherepanov, Vascular Plants of the USSR [in Russian], Nauka, Leningrad (1981).
6. O. A. Kapeller, Flora of the Caucasus [in Russian], Nauka, Leningrad, Vol. 7 (1967), p. 387.
7. D. A. Pakaln, N. F. Komissarenko, I. P. Sheremet, and A. I, Derkach, Useful Plants of the Natural Flora and their Use in the National Economy [in Russian], Naukova Dumka, Kiev (1980), p. 82.
8. I. F. Musaev, Rast. Res., **2**, No. 4, 482 (1966).
9. A. A. Grossgeim, Plant Riches of the Caucasus [in Russian], Izd. Akad. Nauk AzSSR, Moscow (1946).
10. V. P. Makhlayuk, Medicinal Plants in Folk Medicine [in Russian], 2nd ed., Privolzhskoe Kn. Izd.-vo, Saratov (1976).
11. A. Kh. Rollov, Wild Plants of the Caucasus and their Distribution, Properties, and Use [in Russian], Tiflis (1908).
12. M. P. Shumailova, Medicinal and Raw Material Resources of Irkutsk Province [in Russian], Irkutsk, No. 4 (1965), p. 32.
13. I. É. Akopov, Hemostatic Plants [in Russian], Meditsina, Tashkent (1977).
14. A. M. Aliev, Sb. Trudov Azerb. Med. In-ta, No. 4(5), 118 (1958).
15. A. I. Shreter, The Medicinal Flora of the Far East [in Russian], Medgiz, Moscow (1975).
16. N. Annenkov, Botanical Dictionary [in Russian], St. Petersburg (1878).
17. E. N. Zalesova and O. V. Petrovskaya, Complete Russian Illustrated Dictionary — Herbs and Flowering Plants [in Russian], St. Petersburg, Vol. 1 (1898).
18. S. E. Zemlinskii, Medicinal Plants of the USSR [in Russian], Medgiz, Moscow (1958).
19. T. P. Pulatova, Kh. Kh. Khalmatov, and I. N. Dzhuraev, Medicinal Plants of Tashkent Province [in Russian], Meditsina, Tashkent (1980).
20. Flora of Uzbekistan [in Russian], Fan, Tashkent (1961), p. 379.
21. V. I. Vereshchagina, K. A. Sobolevskaya, and A. I. Yakubova, Useful Plants of Western Siberia [in Russian], Izd. Akad. Nauk SSSR, Moscow—Leningrad (1959).
22. Modern Phytotherapy [in Bulgarian], Meditsina i Fizkul'tura, Sofia (1988).
23. N. Stoyanov and B. Kitanov, Wild and Useful Plant in Bulgaria [in Bulgarian], Izd. BAN. Sofia (1960).
24. I. A. Gubanov and N. I. Libazov, Rast. Res., **6**, No. 1, 128 (1970).
25. S. I. Ordynskii and I. D. Martynova, Sb. Nauchn. T.r Leningr. in-ta Usovershchenstv. Vet. Vrachei, No. 9, 138 (1953).
26. N. V. Pavlov, Plant Raw Materials of Kazakhstan [in Russian], Izd. Akad. Nauk SSSR, Moscow—Leningrad (1947).
27. A. A. Grossgeim, Plant Riches of the Caucasus [in Russian], Izd. MOIP, Moscow (1952).
28. I. V. Larin, Sh. M. Agababyan, T. A. Rabotnov, V. K. Larina, M. A. Kasimenko, and A. F. Lyubskaya, Fodder Plants of Hayfields and Pastures of the USSR, Vol. 3 [in Russian], Nauka, Moscow—Leningrad (1956).
29. T. I. Rozhnyatnovskii, Hempnettles, Woundworts and Ironworts as Poisonous Plants for Horses [in Russian], Sb. Tr. Khar'kovskogo. Vet. In-ta, **23**, 379 (1958).

30. T. W. Goodwin and E. Mercer, Introduction to Plant Biochemistry (2nd ed.), Pergamon, Oxford (1982) [Russian translation], Mir, Moscow, Vol. 1 (1986), p. 275].
31. S. Yu. Yunusov, Alkaloids [in Russian], Fan, Tashkent (1981).
32. A. M. Aliev, Dokl. Akad. Nauk AzSSR, **14**, No. 7, 553 (1958).
33. T. P. Pulatova, Khim. Prir. Soedin., 62 (1969).
34. Spice and Aromatic Plants of the USSR and their Use in the Food Industry [in Russian], Pishchepromizdat, Moscow (1963).
35. A. Kh. Akramova, A. U. Umarov, and A. P. Markman, Khim. Prir. Soedin, 244 (1968).
36. B. N. Aronova, E. A. Stegailo, and N. K. Nigmatullina, Sov. Zdravookhranenie Kirgizii, No. 1, 44 (1970).
37. P. M. Subbotin, Tr. Leningr. Nauch-Prakt. Farmats. In-ta, **1**, 108 (1935).
38. A. I. Karaev, R. K. Aliev, and P. A. Yuzbashinskaya, Dokl. Akad. Nauk, AzSSR, **11**, No. 3, 187 (1955).
39. B. N. Aronova, A Pharmacological Study of *Stachys betoniciflora* and Biological Evaluation of Preparations from it [in Russian], Author's abstract of dissertation ... Candidate of Pharmacological Sciences [in Russian], Nauka, Moscow (1968).
40. A. M. Aliev, Materials on the Investigation of *Stachys lanata* and *Stachys balansae* Growing in Azerbaizhan [in Russian], Author's Abstract of Candidate's Dissertation, Baku (1958).
41. G. V. Novitskaya and V. I. Krishtopa, Rast. Res., **7**, No. 1, 32 (1971).
42. G. V. Novitskaya and V. I. Mal'tseva, Rast. Res., **3**, No. 3, 438 (1967).
43. M. I. Goryaev, Essential Oils of the Flora of the USSR [in Russian], Izd. Akad. Nauk KazSSR, Alma-Ata (1952).
44. V. I. Nilov and V. V. Vil'yams, "Materials on the investigation of the essential oils of Crimean plants" [in Russian], Zap. Gos. Nikit. Bot. Sada, No. 1, 3 (1926).
45. S. Ya. Sokolov and I. P. Zamotaev, Handbook of Medicinal Plants (Phytotherapy) [in Russian], Metallurgiya [*sic* — Meditsina], Moscow (1990).
46. D. P. Popa and G. S. Pasechnik, Khim. Prir. Soedin., 447 (1974).
47. T. M. Orgiyan and D. P. Popa, Khim. Prir. Soedin., 7 (1969).
48. D. P. Popa and T. M. Orgiyan, Khim. Prir. Soedin., 406 (1974).
49. D. P. Popa and T. M. Orgiyan, Khim. Prir. Soedin., 295 (1974).
50. D. P. Popa, T. M. Orgiyan, and Kh. Sh. Kharitonov, Khim. Prir. Soedin., 324 (1974).
51. P. Atkins, Molecules, Scientific American Library, W. H. Freeman, New York (1987).
52. B. N. Aronova and B. I. Litvinenko, Physiologically Active Compounds from the Plants of Kirgiziya [in Russian], Frunze (1970).
53. A. I. Derkach, N. F. Komissarenko, and D. A. Pakaln, Rast. Res., **23**, No. 1, 92 (1987).
54. T. V. Zinchenko and T. Ya. Myaushko, Farm. Zh., No. 5, 64 (1972).
55. N. F. Komissarenko, A. I. Derkach, I. P. Sheremet, and D. A. Pakaln, Khim. Prir. Soedin., 109 (1976).
56. N. F. Komissarenko, A. I. Derkach, I. P. Sheremet, and D. A. Pakaln, Khim. Prir. Soedin., 99 (1979).
57. V. I. Litvinenko and B. N. Aronova, Khim. Prir. Soedin., 319 (1968).
58. V. A. Paseshnichenko, The Biosynthesis and Biological Activity of Plant Terpenoids and Steroids [in Russian], Vol. 25 of Itogi Nauk i Tekhniki, VINITI, Biologicheskaya Khimiya (1987).
59. T. V. Zinchenko, Khim. Prir. Soedin., 266 (1970).
60. O. I. Kostyuchenko, The Phenolcarboxylic Acids of *Stachys atherocalyx*. A Phytochemical Study of the Flora of the Belorussian SSR and Biopharmaceutical Investigations of Medicinal Preparations [in Russian], Leningrad, Nauka (1975), p. 89.
61. V. I. Litvinenko, Some Questions of the Chemistry and Taxonomy of the Labiatae Family, the Plant Resources of the Ukraine, their Isolation and Rational Use [in Ukranian], Naukova Dumka, Kiev (1973), p. 128.
62. V. A. Bandyukova, Khim. Prir. Soedin., 263 (1983).
63. V. G. Minaeva, Flavonoids in the Ontogenesis of Plants and their Practical Use [in Russian], Nauka, Sib. Otdelenie, Novosibirsk (1978).
64. L. K. Klyshev, V. A. Bandyukova, and P. S. Alyukina, Plant Flavonoids [in Russian], Nauka, Alma-Ata (1978).
65. O. I. Kostyuchenko and T. V. Zinchenko, "*Stachys atherocalyx* — a raw material for a new cholagogic drug," Proceedings of the IIIrd Congress of Pharmacists of the Belorussian SSR [in Russian], Minsk (1977), p. 159.

66. N. F. Komissarenko, A. I. Derkach, I. P. Sheremet, I. P. Kovalev, I. P. Gordenko, and D. A. Pakaln, Khim. Prir. Soedin., 521 (1978).
67. A. I. Derkach, N. F. Komissarenko, V. G. Gordienko, I. P. Sheremet, I. P. Kovalev, and D. A. Pakaln, Khim. Prir. Soedin., 172 (180).
68. V. I. Glyzin, A. I. Ban'kovskii, V. S. Kabanov, V. I. Sheichenko, and A. A. Kir'yanov, "The structures of flavonoid glycosides from *Stachys palustris*," in: Proceedings of the IIIrd All-Union Congress of Pharmacists [in Russian], Sverdlovsk (1975), p. 288.
69. O. I. Kostyuchenko, N. F. Komissarenko, I. P. Kovalev, A. I. Derkach, and V. G. Gordienko, Khim. Prir. Soedin., 187 (1982).
70. I. Kh. Pasechnik, O. I. Kostyuchenko, and T. V. Zinchenko, Farm. Zh., No. 1, 89 (1975).
71. Samir Anis Ross, A Phytochemical Study of *Stachys palustris* as a Source of New Drugs, Author's abstract of dissertation for Candidate of Pharmaceutical Sciences [in Russian], Kiev (1976).
72. A. D. Turova, Medicinal Plants of the USSR and their Use [in Russian], Meditsina, Moscow (1974).
73. O. I. Kostyuchenko, Rast. Res., **13**, No. 2, 403 (1977).
74. B. N. Aronova, Rast. Res., **5**, No. 3, 422 (1969).
75. T. V. Zinchenko, Farm. Zh., No. 4, 81 (1970).
76. I. P. Sheremets and N. F. Komissarenko, Khim. Prir. Soedin., 721 (1971).
77. N. F. Komissarenko, I. P. Sheremets, A. I. Derkach, and D. A. Pakaln, Khim. Prir. Soedin., 98 (1976).
78. Samir Anis Ross, T. V. Zinchenko, and E. E. Borzunov, Ukr. Khim. Zh. **41**, No. 10 1108 (1975).
79. I. P. Sheremet and N. F. Komissarenko, Khim. Prir. Soedin., 646 (1972).
80. I. P. Sheremet and N. F. Komissarenko, Khim. Prir. Soedin., 581 (1971).
81. I. P. Sheremet and N. F. Komissarenko, Khim. Prir. Soedin., 845 (1971).
82. Samir Anis Ross, T. V. Zinchenko, G. K. Nikonov, E. E. Borzunov, Ukr. Khim. Zh., **42**, No. 3, 284 (1976).
83. O. I. Kostyuchenko, N. F. Komissarenko, T. V. Zinchenko, and A. I. Derkach, Khim. Prir. Soedin., 389 (1981).
84. V. P. Georgievskii, N. F. Komissarenko, and S. E. Dimitruk, Biologically Active Substances of Medicinal Plants [in Russian], Nauka, Sib. Otdelenie, Novosibirsk (1990).
85. T. Ya. Omel'chuk-Myaushko and T. V. Zinchenko, Ukr. Bot. Zh., **31**, No. 5, 636 (1974).
86. D. E. Dionis'ev and E. E. Chernomaz, "An investigation of the poisonous principles of some wild herbs," Uchen. Zap. Rostovskogo N/D Un-ta, No. 9, 66 (1938).
87. A. I. Shreter, A. S. Gladkikh, A. I. Gubanov, M. G. Pimenov, and R. E. Pimenova, Rast. Res., **2**, No. 1, 3 (1966).
88. Poisonous Plants of Meadows and Pastures [in Russian], Izd-vo Akad. Nauk SSSR, Moscow—Leningrad (1950).
89. Samir Anis Ross and T. V. Zinchenko, Farmats. Zh., No. 3, 91 (1975).
90. I. A. Pankova, Herbaceous Plants Containing Vitamin C. Plant Raw Material [in Russian], Nauka, Leningrad (1949), p. 292.
91. I. G. Zoz and V. I. Litvinenko, Bot. Zh., **64**, No. 47, 989 (1979).
92. P. M. Subbotin, "The action of *Stachys sylvestris* on the uterus" in: Tr. Leningr. Nauch. Prakt.-farm. In-ta, **1**, 108 (1935).
93. S. I. Ordynskii and I. D. Martynova, "The pharmacology of *Stachys sylvestris,"* Sb. Nauch. Tr. Leningr. In-ta Usovershchenstv. Vet. Vrachei, No. 9, 138 (1953).
94. A. I. Petchenko, Physiology and Pathology of the Contractile Capability of the Uterus [in Russian], Medgiz, Leningrad (1948).
95. E. A. Stegailo, I. M. Lebedeva, B. N. Aronova, N. V. Balakhova, and D. A. Kharmau, Akusterstvo i Ginekologiya, No. 2, 19 (1980).
96. L. A. Ivanova, "The use of a tincture of *Stachys betoniciflora* in Gynecological Practice," Sov. Zdravookhr. Kirgizii, No. 2, 11 (1959).
97. P. I. Lukienko, "The pharmacology of *Stachys betoniciflora*. Communication 2. Influence of *Stachys betoniciflora* on the rate of blood clotting," Tr. Kirg. Gos. Med. In-ta, **8**, 203, (1956).
98. P. I. Lukienko, "The pharmacology of *Stachys betoniciflora*. Communication 3. Reaction of the central nervous system to the administration of a tincture of *Stachys betoniciflora*," Tr. Kirg. Gos. Med. In-ta, **12**, 74 (1959).
99. P. I. Lukienko and N. K. Nigmatullina, "The extrogenic properties of tinctures of *Stachys betoniciflora* and *Lamium album,"* Tr. Kirg. Gos. Med. In-ta, **15**, 105 (1961).

100. P. I. Lukienko, "The pharmacological properties of *Stachys betoniciflora* and some other plants of the Labiatae family," in: 1st Congress of Physiologists, Biochemists, and Pharmacologists of Central Asia and Kazakhstan [in Russian], Tashkent (1958), p. 438.
101. I. Kh. Pasechnik, Farmakol. Toksikol., **32**, No. 5, 575 (1969).
102. I. Kh. Pasechnik and M. A. Garbarets, Vrachebn. Delo, No. 10, 5 (1969).
103. I. Kh. Pasechnik, T. V. Zinchenko, and M. A. Garbarets, Farm. Zh., No. 3, 64 (1971).
104. V. S. Volkov, E. M. Kurasova, and A. V. Semenyuk, "Experience in the use of Caucasian yam and Stakhiglen on patients suffering from chronic gastritis with secretory insufficiency," in: The Prophylaxis and Treatment of Diseases of the Gastrointestinal Tract [in Russian], Omsk (1976), p. 26.
105. Yu. V. Roshchin and G. I. Gerashchenko, "The antiophlogistic activity of some flavonoids," in: Questions of Pharmacy in the Far East [in Russian], Kharabovsk, No. 1 (1973), p. 134.
106. G. N. Lipkan, T. V. Zinchenko, and O. I. Kostyuchenko, "A study of the toxicity and antiphlogistic activity of the polyphenolic complexes of *Stachys germanica* and *Stachys atherocalyx*," in: Modern Problems of Pharmaceutical Science and Practice [in Russian], Kiev (1972), p. 912.
107. G. M. Lipkan, N. P. Maksyutina, and T. V. Zinchenko, Farm. Zh., No. 1, 78 (1974).
108. Z. B. Rudova and T. B. Zinchenko, "The use of monthly cycles of specific treatment in chronic forms of cerebral toxoplasmosis in combination with the drug Stakhiren," in: Modern Problems of Pharmaceutical Science and Practice; Abstracts of Lectures at the IInd Congress of Pharmacists of the UkrSSR [in Russian], Kiev (1972), p. 905.
109. O. V. Kandaurova, P. V. Zhuk, and E. V. Bereslavets, "The use of the new plant drug Palyustakhin under the conditions of a disturbance of liver function," Tr. Krym. Med. In-ta, **65**, 72 (1975).
110. V. N. Savchenko, "A study of the antiphlogistic action of a drug from *Stachys inflata*," in: Abstracts of Lectures at the 1st Ukrainian Congress of Pharmacologists [in Russian], Vinnitsa (1977), p. 157.
111. V. M. Savchenko, M. F. Komissarenko, and D. A. Pakaln, Farm. Zh., No. 2, 55 (1981).
112. B. A. Vartazaryan, "Influence of flavones on the cholepoietic function of the liver," Sb. Tr. Kurskogo Med. In-ta, No. 12, 1-152 (1957).