COMPARATIVE ANALYSIS OF MONOGRAPHS ON *HERBAL DRUGS* AND *HERBAL DRUG PREPARATIONS* INCLUDED IN THE EUROPEAN PHARMACOPOEIA (*PH. EUR. 8*)

G. Kitanov, D. Karcheva, P. Lukova

Departament of Pharmacognosy and pharmaceutical chemistry, Faculty of Pharmacy, Medical University-Plovdiv, Bul. Vasil Aprilov 15A, 4002 Plovdiv, Bulgaria

Abstract. The comparative analysis of pharmacopoeial articles on *Herbal drugs* and *Herbal drug preparations* (tinctures, extracts, essential oils, vegetable fatty and fish oils) shows a continuous increase in the number of monographs in the different editions of the European Pharmacopoeia (from 40 articles in Ph. Eur. 3 to 306 in Ph. Eur. 8). They constitute approximately 16% of the total number of pharmacopoeial articles. The total number of articles on *Herbal drugs* included in the last edition (Ph. Eur.8) is 170. In this edition, drugs from roots and rhizomes prevail (43) followed by herbs (30) and leaves (27). Largest is the number of drugs containing essential oils (33), flavonoids (24) and mucilages (17). The number of monographs on *Herbal drug preparations* in Ph. Eur.8 is 136: 63 articles are for galenical preparations (tinctures, extracts, homoeopathic preparations), 33 monographs for essential oils and 40 articles on vegetable and animal fats, oils and waxes). Amongst galenical preparations, the largest is the number of dry extracts (22) followed by the monographs on tinctures (15) and homoeopathic preparations (9). According to the content of active substances in pharmacopoeialgalenical preparations, largest is the number of preparations containing alkaloids (14 articles), followed by essential oil drug preparations (9), flavonoid and anthraquinone (6 and 5 monographs respectively). An important conclusion is the introduction of more accurate and sophisticated instrumental methods for analysis of active components in herbal drugs and herbal drug preparations. The main methods used for analysis are spectrometric (for phenolic substances), gas chromatography (for essential oils) and HPLC for almost all other groups of active substances.

Key words: European Pharmacopoeia, Herbaldrugs monographs, Herbal drug preparations monographs, Comparative analysis

Introduction

Plants and products of plant origin are an inexhaustible and vital source for obtaining foodstuffs. They are also used in other areas of human activity. An inalienable part of the application of such products of plant origin is application in medicine and pharmacy. Herbal drugs, products and substances thereof intended for medicinal purposes must meet a number of specific requirements which are to guarantee their medical efficacy and safety for human health.

Standardisation aims to establish and apply standards and rules which ensure the most efficient plant raw materials for application in medical practice. To achieve this goal at national, regional and international level, strict regulatory requirements have been developed for the quality of feedstock from which medicinal products are obtained. Many national and international institutions deal are involved in the creation and publication of monographs on herbal drugs with a view to create standards not only for drugs' quality but also for their efficacy and safety.

According to the decisions of a number of international forums (the conference in Australia 1999; symposium in France 2000, etc.) [1,2,3,4,5,6,7], current quality of herbal drugs for pharmaceutical reasons must be established and measures must be mapped out for future development in this field. To improve the quality of drugs and phyto products, collaboration between the parties from individual regions worldwide must intensify, analytical

standardisation procedures must be created and the following rules observed: it must be ensured that plant material is well identified through botanic and chemical parameters; that there are secure methods to prove the presence of contamination; that biologically active components in drugs are quantified; that the difference among individual batches through a good agronomic practice and homogenous plant sources is minimised; where possible, methods must be developed for characterisation of biological activity through a biological analysis and/or through a chemical profile; a simple toxicity test must ensure that despite the beneficial properties of the drug, the level of its toxicity is acceptable.

The World Health Organisation (WHO) has drawn up and published extensive monographs in 5 volumes about 147 herbal drugs from medicinal plants which are widely used in practice [8]. They include sections with very detailed information about the origin of the plant, identification, chemical composition, pharmacological and clinical trials, efficacy and safety, therapeutic administration, dosage, side effect warnings, contraindications and many other useful details about drugs obtained from these plants.

Of similar nature are the articles (ESCOP Monographs) which are developed and created by the European Scientific Cooperative on Phytotherapy [9]. A total of 115 monographs for plant drugs have been published, identified as SPCs (Specific Product Characteristics). These are monographs catering to EU needs and aim to harmonise requirements for plant drugs and their therapeutic use in the process of EU Member States integration. Monographs do not deal directly with the quality standards of herbal drugs which are the subject matter of the EU and other pharmacopoeias and provide much detailed information about therapeutic use, dosage, side effects and other specific guidelines.

To raise the requirements for plant drugs for medicinal purposes, the European Medicines Agency (EMA) set up a working group for herbal medicinal products, namely the Herbal Medicinal Products Committee (HMPC). It develops, reviews, accepts and offers to the European Commission for acceptance monographs for safety and efficacy of plant drugs (Community Monographs for Herbal Medicinal Products with well-established medicinal use), which are valid for Member States of the European Union (EU) [10].

To enhance quality and harmonise requirements in individual EU Member States for plant drugs, products and substances from plants intended for use in pharmacy and medicine, European Pharmacopoeia (Ph. Eur.) [11] was created in the EU, which with order No. RD – 09350 (SG issue 65 of 1995) of the Health Minister was transposed as mandatory for Bulgaria (Ph. Eur. 2). Interest and progress in the quantification and use of herbal drugs and products of plant origin in the EU is evidenced in the growing number of articles included in each subsequent edition of the European Pharmacopoeia. Thus, for example, in issue III (Ph. Eur. 3) of 1997, only 34 drugs were included while plant drug quantification articles included in the next editions is a multiple of this figure.

In Bulgaria, quantification of plant drugs until 1994 used to be done in accordance with the Bulgarian State Standards (BDS) and the State Pharmacopoeia X of the USSR [12, 13]. In the years after 1995, this is being performed in accordance with the mandatory of European Pharmacopoeia.

Purpose

According to Ph. Eur. 4, plant products for medicinal and pharmaceutical purposes are defined as *Herbal drugs*, *Herbal teas* and *Herbal drug preparations*. Preparations include products obtained through secondary processing of medicinal plants or drugs after treatment such as extraction, distillation, squeezing, fractioning, cleansing, concentration, fermentation and other processes. These are crushed or reduced to dust medicinal plants, tinctures, extracts, essential oils, fat oils, squeezed juices and processed exudates.

The purpose of this study is to make a comparative analysis of pharmacopoeic articles about *Herbal drugs* and *Herbal drug preparations* included in the European Pharmacopoeia 8 (Ph. Eur. 8) with regard to their number, composition of active substances, method of qualification and other parameters.

Results and discussion

Presently, analysis and standardisation play an exceptionally important role for enhancing the quality of drug and phyto products derived from them. Strict requirements for the quality of drugs lead to tangible improvement of their therapeutic effect and commercial value. Monographs in pharmacopoeias are developed primarily for drugs which have been well established as medicinal products in various countries. They have a well studied and known chemical composition, an accurately defined pharmacological effect and therapeutic use, as well as clinically proven efficacy and safety. The review of

Table 1. *Number of monographs on Herbal drugs and Herbal drug preparations in the different editions of Ph. Eur.*

Edition of Ph. Eur..	Herbal drugs	Herbal drug preparations
Ph. Eur. 3, 1997	34	6
Ph. Eur. 4, 2002	117	63
Ph. Eur. 5, 2005	123	82
Ph. Eur. 6, 2008	148	118
Ph. Eur. 7, 2011	156	133
Ph. Eur. 8, 2014	170	136

the individual editions of the European Pharmacopoeia shows continuous increase in the number of published articles about herbal drugs, products and plant-sourced substances used for medicinal purposes or for use in the pharmaceutical industry, as is specified in Table 1.

The IIIrd edition of Ph. Eur. (Ph. Eur. 3, 1997) includes 40 monographs about drugs and plant products, 34 of which refer to drugs and the remaining 6 are for fat and essential oils. Out of the drugs described in the pharmacopoeia, only a small portion (12 in all) is obtained from drugs which are gathered in Bulgaria and are the subject matter of intensive commercial activity. All the rest are derived from foreign plants which are not grown in Bulgaria and are solely imported.

The IVth edition (Ph. Eur. 4, 2002) contains monographs about 117 drugs, rubbers and balsams as well as 63 articles about herbal drug preparations.

The Vth edition (Ph. Eur. 5, 2005) contains descriptions of 123 herbal drugs and has 82 articles about drug preparations (of which 29 articles about galenic plant-based phyto products, 24 for essential oils and 29 for fatty oils and waxes).

In the VIth edition (Ph. Eur. 6, 2008) the number of pharmacopoeial drugs and phyto products is much larger compared to the previous editions. It contains the total number of drugs 148, whereas the monographs of natural preparations is 118 (there are 50 articles about galenic phyto products, 29 monographs about essential oils and 39 articles about plant oils, fish oils and waxes).

In the VIIth edition (Ph. Eur. 7, 2011) these data are 156 monographs for herbal drugs and 133 for herbal drug preparations.

In the VIIIth edition of the Ph. Eur., which is valid from the start of 2014 (Ph. Eur. 8, 2014) the total number of monographs for herbal drugs is 170, and that of herbal drug preparations is 136, of which 63 articles are about galenic herbal drug preparations (tinctures, extracts, homoeopathic preparations), 33 monographs about essential oils and 40 articles about plant and fish fatty oils and waxes.

A comparative analysis of the monograph count included in the VIIIth edition of Ph. Eur. shows that the articles about herbal drugs, herbal drug preparations and fish oils (a total of 306) are around 16% of the total number of pharmacopoeial articles.

Herbal drugs.

According to the plant parts, articles about drugs in Ph. Eur. 8 are distributed as follows (Table 2).

As is clear from the table, drugs from roots and underground parts are the most numerous followed by stems, leaves, fruit and flowers. Articles have been developed for qualification of dressings (articles about

Table 2. *Herbal drugs by morphological groups included in the Ph. Eur. 8*

Morphological groups	Number of monographs
General monograph on herbal drugs (*Plantae medicinales, Herbal drugs)*	1
General monograph on herbal teas (*Planta ad ptisanam, Herbal teas*)	1
Radix, Rhizoma; Bulbus	43
Herba	30
Folium	27
Fructus	19
Flos	16
Cortex	8
Semen	7
Resina, Balsamum	7
Algae, Fungi, Lichen	4
Aloe succus, Opium	3
Gummi	2
Lanugo, Alignin	2
Total:	**170**

cotton, artificial cotton); two articles about algae (agar and thallus from the algae *Fucus ascophyllum* (kelp); three monographs about natural plant juices which have not undergone extra processing (dry juice out of *Aloe barbadensis*, dry juice out of *A. capensis*, raw opium); two articles about plant gum (arabic gum and tragacanth); seven monographs about resins and balsams (myrrh, mastic, Indian frankincense, Peru balsam and Tolu balsam, benzoin resin, benzoin Sumatra and benzoin Siam); one article about lichen (Iceland moss), one article about fungi (*Poria cocos*), and one article about epicarp and pericarp of bitter orange.

According to the contents of active substances and through which pharmacopoieal drugs are qualified in the articles, distribution is as follows (Table 3).

Table 3. *Herbal drugs classified according to their content of active substances included in the Ph. Eur. 8*

Content of active substances	Number of monographs
General monographs on herbal drugs and herbal teas	2
Containing essential oils	33
Containing flavonoids	24
Containing mucilage	17
Containing alkaloids	14
Containing hydroxycinnamic acids	11
Containing tannins	11
Containing saponins	11
Containing anthraquinones	9
Containing simple phenolic compounds and hydroxybenzoic acids	7
Containing iridoids	6
Containing sesquiterpene lactones	4
Containing lignans	3
Containing coumarins	3
Containing organic acids	2
Containing anthocyanidins	2
Containing diterpenes	2
Containing sterols	2
Containing cellulose	2
Containing cardiac glycosides	1
Containing sulfur compounds	1
Containing amino acids	1
Containing polyglucans from fungi	1
Containing iodine	1
Total:	**170**

The largest is the number of drugs containing and qualified by contents of essential oils (33 monographs). Determination takes place through distillation with water vapour and is issued in mL/kg for uncut and in some instances for cut drugs. Sometimes oil is additionally determined with gas chromatography and the content of some of the main components is indicated.

The number of plant drugs which are qualified by content of flavonoids is high (24 articles). The most common method for quantitative determination is spectrometric with a solution of aluminium trichloride but it is growingly replaced with HPLC. In most cases as a standard for comparison is used hyperoside (quercetin-3-O-galactoside), whereas in some drugs the flavonoid content is calculated as isoquercitroside (*Sambuci flos, Equiseti herba),* rutoside (*Sophorae japonicae flos immaturus, Fagopyri herba),* flavone baicalin (*Scutellariae baicalensis radix*), the flavanones naringin *(Aurantii amari flos)* and naringenin (*Drynariae rhizoma),* the isoflavone puerarin (*Puerariae lobatae radix, Puerariae thomsonii radix),* the flavolignane silybin *(Silybi mariani fructus),* C-glycosides violantin (*Violae herba cum flore*) and vitexin (*Passiflorae herba)*. Some drugs are qualified by content of flavonoids despite that the active components are not known or are other substances (*Leonuri cardiacae herba, Orthosiphonis folium, Agni casti fructus*).

The spectrometric method is the main one and upon characterisation of all anthraquinone drugs, anthocyanin-containing drugs, tannins, cardiac glycosides.

Third-ranked in terms of monograph count are drugs containing polysaccharides: resins, marine algae and mucilage (17 in total). For qualification of the content of mucilage, the Swelling index (SI) method is used.

Some of the alkaloids in the herbal drugs (14 monographs) are determined by the classical way through titration; however, most of them are characterised through HPLC.

The HPLC is the main method in the determination of the content of active substances in drugs containing derivatives of hydroxybenzoic and hydroxycinnamic acids, coumarins, lignans, iridoids, sesquiterpene lactones and saponins.

A number of drugs are qualified by hydroxycinnamic acids, their depsides or glycosides, which in some cases are the active substances and in other cases they are specific to a given drug: caftaric and cichoric acids (*Echinaceae purpureae radix, Echi-*

naceae purpureae herba), echinacoside (*Echinaceae angustifoliae radix, Echinaceae pallidae radix*), chlorogenic acid, cynarin (*Cynarae folium, Fraxini folium*), caffeoyl-malic acid (*Urticeae folium*), transferulic acid (*Angelicae sinensis radix*), diferuylmethane (curcumin) (*Curcumae xanthorrhizae rhizoma*), rosmarinic acid (*Rosmarini folium, Melissae folium*), ortho-hydroxycinnamic acids as acteoside (*Plantaginis lanceolatae folium, Ballotae nigrae herba, Verbenae citriodoratae folium*).

Some drugs are characterised by two groups of substances, most often essential oil (EO) and hydroxy-derivatives of cinnamic acids (*Curcumae xanthorrhizae rhizoma, Rosmarini folium, Verbenae citriodoratae folium)*, essential oils and flavonoids (*Matricariae flos),* essential oils and sesquiterpene lactones as valerenic acid (*Valerianae radix)*.

In four drugs, only extractive substances are still defined, which do not give an idea about the contents of ingredients determining the effect and use of the drug (*Graminis rhizoma, Lupuli flos, Ononidis radix, Pruni africanae cortex, Myrrha)*.

In some articles only chromatographic analysis is present without any quantitative determination *(Tiliae flos, Taraxaci officinalis herba cum radix, Taraxaci officinalis radix, Primulae radix, Polygalae radix, Papaveris rhoeados flos, Poria)*.

In three monographs, containing very bitter secoiridoids, the Index Amara (IA) is determined (*Gentianae radix,* IA minimum 10000; *Centaurii herba,* IA minimum 2000; *Menyanthidis trifoliatae folium,* IA minimum 3000).

In the case of kelp thallus (*Fucus vel Ascophyllum),* the contents of iodine is determined (min. 0.03% and max. 0.2% total iodine).

Herbal drug preparations.

The type and number of 136 herbal drug preparations, included in Ph. Eur. 8 (tinctures, extracts, homoeopathic preparations, essential oils, plant and animal fatty oils and waxes) is given in Table 4.

As is clear from the table, the largest number of articles is for dry extracts (22 monographs), followed by monographs about tinctures (15 articles). This is understandable since dry extracts have a number of advantages such as higher contents of active substances, more stability, easier inclusion in hard and modelled pharmaceutical forms, etc. Extracts are characterised with the Drug:Extract Ratio; (DER_{native}). DER is an indicator which shows the ratio between the quantity of feedstock to the quantity of the total extract derived with an accurately determined contents of active substances. If, for example, DER is 3–6:1, this corresponds to extracted substances contents of 33-17%, whereas the quantity of drug for extraction used is from 3 to 6 times more than the extract obtained with the same quantity of active substances.

For example, the extract from the plant *Vitex agnus castus* which is included in medicinal products has DER of approximately 6-12:1 which means that 20 mg of extract (which is accepted as effective dose of the extract) is derived and corresponds to 120-240 mg of dry drug.

Table 4. *Herbal drug preparations and fish oils in groups depending on their preparation included in Ph. Eur. 8*

Group of herbal drug preparations	Number of monographs
General monograph on herbal drug preparations (*Plantae medicinales praeparatae*)	1
General monograph on herbal drugs for homoeopathic preparations (*Plantae medicinales ad preparationes homoeopathicas*)	1
General monograph on mother tinctures for homoeopathic preparations (*Tinctura maternae ad praeparationes homoeopathicas*)	1
Extracta siccum	22
Extracta fluidum	5
Extracta spissum	1
Tinctura	15
Pulvis normatus	4
Varia	4
Preparationes homeopathicas	9
Total:	**63**
General monograph on essential oils (*Aetherolea*, *Oleum aetherolaeum*)	1
Essential oils	32
Total:	**33**
General monograph on vegetable fatty oils (*Olea herbaria,Vegetable fatty oils*)	1
Lipids (vegetable oils)	24
Lipids (fish oils)	8
Lipoids (waxes and others)	7
Total:	**40**

In The European Pharmacopoeia, monographs for the two types of extracts are included: standardised and quantified extracts.

Standardised are extracts in which the quantity of compounds responsible for the therapeutic efficacy of the extract is determined and limits "from-to" about the contents of active substances in the extract. For example, all pharmacopoeial herbal drug preparations containing alkaloids and anthraquinones are standardised.

Quantified are those extracts where the characteristic compounds are not yet fully known and they may be responsible or not for the therapeutic activity. They require minimum contents of active substances "no less than", "minimum" or two or more compounds or groups of substances are determined.

"*Pulvis normatus*" includes titrated powders from Belladonna leaves *(Belladonnae pulvis normatus)*, Stramonium leaves *(Stramonii pulvis normatus)*, raw opium *(Opii pulvis normatus)* and Ipecacuanha roots *(Ipecacuanhae pulvis normatus)* which are diluted with an indifferent substance (most often lactose) and have the precise contents of active substances. The content of active substances is brought to the pharmacopoieal requirements for the drug (standardised drug preparations).

"*Varia*" includes bee honey (*Mel depuratum)*, dispersed and dried arabic gum (*Acaciae gummi dispersione desiccatum)*, alginic acid *(Acidum alginicum)* and active carbon (*Carbo activatus)* from various types of wood.

Nine mother tinctures are categorised as homoeopathic products: oriental cashew *(Semecarpus anacardium (Anacardium orientale)),* St. John's wort *(Hypericum perforatum)*, Saffron (*Crocus sativus)*, Ivy *(Hedera helix),* Black henbane *(Hyoscyamus niger),* Garlic *(Allium sativum),* Nettle *(Urtica dioica),* Goldenseal *(Hydrtastis canadensis)* and Honey bees *(Apis mellifera ad praeparationes homoeopathicas).*

The number of articles for essential oils increases with each next edition of pharmacopoeia. All oils are characterised through gas chromatography and minimum content of one or more of the main components is required.

The number of monographs about lipids and lipoids in Ph. Eur. 8 does not change tangibly compared to the number of articles in Ph. Eur. 7. For all fixed oils, apart from the classical parameters such as relative weight, acid, saponification, ester and iodine values and other requirements, percentage contents of the main acids in the composition of glycerides is provided.

In fish oils, quantification takes place primarily with the total content of omega-3 acides and using a special minimum percentage contents of the important omega-3 acids: EPA (Eicosapentaenoic acid; C20:5 n-3) and DHA (Docosahexaenoic acid; C22:6 n-3).

To the lipoids refer two articles about Bee wax (white and yellow wax), Carnauba wax and four monographs about lanolin and its derivatives. They are quantified by melting point, acid, ester and oxidation values.

According to the content of active substances in the pharmacopoeial herbal drug preparations, the articles shall be distributed as follows (Table 5).

As is clear from the table, the largest is the number of alkaloid-containing preparations (14 articles). Six articles of them are about extracts, 4 about tinctures and 4 about titrated powders. All are quantified by their active ingradients (alkaloids), and, except for one (*Boldi folii extractum siccum*), a lower and upper limit for content of pharmacologically active substances is given (standardised preparations).

Table 5. *Herbal drug preparations by groups based on the content of active substances included in Ph. Eur. 8*

Content of active substances	Number of monographs
General monographs on herbal drug preparations, herbal drugs for homoeopathic preparations and mother tinctures for homoeopathic preparations	3
Containing mono-, oligo- and polysaccharides	3
Containing active carbon	1
Containing hydroxybenzoic and hydroxycinnamic acids	2
Containing hidroxyanthracene derivatives (anthraquinones)	5
Containing flavonoids and anthocyanins	6
Containing tannins	2
Containing essential oils	9
Containing resins and balsams	3
Containing iridoids	3
Containing sesquiterpene lactones	1
Containing saponins	2
Containing alkaloids	14
Homeopathic mother tinctures	9
Total:	**63**

The same refers to galenic anthraquinone-containing preparations (5 monographs) which are standardised and limits for content of active substances are provided.

The two extracts from sweet root *(Liquiritiae extractum fluidum ethanolicum normatum, Liquiritiae extractum siccum ad saporandum*) are also characterised using a precisely determined contents of the glycyrrhizic acid and refer to the standardised extracts.

For all other preparations (containing hydroxybenzoic derivatives, flavonoids, tannins, essential oils, resins and balsams, iridoids and sesquiterpene lactones) pharmacopoeial articles require minimum content of active substances whereas in *Gentianae tinctura* bitter index has been defined (IA, minimum 1000).

Despite the significant number (9 monographs) of tinctures and extracts of essential oil drugs, only 2 of them are characterised by content of essential oil (*Salviae tinctura, Matricariae extractum fluidum*). The remainder are quantified by contents of rosmarinic acid (*Mentae piperitae folii extractum siccum, Melissae folii extractum siccum),* by sesquiterpene acids such as valerenic acid *(Valerianae extractum hydroalcoholicum siccum, Valerianae extractum aquosum siccum, Valerianae tinctura*) and by dry residue (*Aurantii amari epicarpii et mesocarpii tinctura, Cinnamomi corticis tinctura).*

In monographs of three extracts, content of more groups of pharmacologically active substances is required: *Hyperici herbae extractum siccum quantificatum* (content of total hypericins, expressed as hypericin - 0.1 to 0.3%; flavonoids, expressed as rutin - minimum 6%; phloroglucinols, expressed as hyperforin - maximum 6%); *Ginkgonis extractum siccum raffinatum et quantificatum* (content of flavonoids 22 to 27%; the sesquiterpene lactone bilobalide 2,6 to 3,2%; diterpenes ginkgolides A, B, C 2,8 to 3,4%; ginkgolic acids maximum 5 ppm); *Silybi mariani extractum siccum raffinatum et normatum* (the nominal content of silymarin 30-65%, corresponds to the sum of contents of silibinin A and silibinin B 40-65%, silicristin и silidianin 20-45%, isosilibinin A and isosilibinin B 10-20%).

The requirements for most homoeopathic products (9 mother tinctures) are lower and they are mainly characterised only by proving characteristic components for the herbal raw material from which they are derived, without requiring quantitative contents of these components.

Conclusion

The comparative analysis of pharmacopoeial articles on herbal drugs and herbal drug preparations (tinctures, extracts, essential oils, vegetable fatty and fish oils) shows a continuous increase in the number of monographs in the different editions of the European Pharmacopoeia (from 40 articles in Ph. Eur. 3 to 306 in Ph. Eur. 8). They constitute approximately 16% of the total number of pharmacopoeial articles.

The total number of articles on *Herbal drugs* included in the last edition (Ph. Eur. 8) is 170. In this edition, drugs from roots and rhizomes prevail (43) followed by herbs (30) and leaves (27). Largest is the number of drugs containing essential oils (33), flavonoids (24) and mucilages (17).

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According to the content of active substances in pharmacopoeial galenical preparations, largest is the number of preparations containing alkaloids (14 articles), followed by essential oil drug preparations (9), flavonoid and anthraquinone (6 and 5 monographs respectively).

An important conclusion is the introduction of more accurate and sophisticated instrumental methods for analysis of active components in herbal drugs and herbal drug preparations. The main methods used for analysis are spectrometric (for phenolic substances), gas chromatography (for essential oils) and HPLC for almost all other groups of active substances.

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✉ **Corresponding author:**
Gerassim Kitanov
Departament of Pharmacognosy and pharmaceutical chemistry, Faculty of Pharmacy,
Medical University-Plovdiv, Vasil Aprilov bul. 15A, Plovdiv, Bulgaria
Phone: +35929563789
Mobile: +359898550444
e-mail: gerassim.kitanov@gmail.com