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Determination of technological parametrs and good quality of phyto-tea based on medicinal peony (*Paeonia officinalis l.*)

***Zulfia* Zuparova[1,*], *Gulnoza* Sadikova[2], *Guzaloy* Ismoilova[2], *Gayrat* Djanaev[1], *Jasurbek* Kholmatov[1], *Munira* Mamadjanova[1]**

[1]Department of Pharmacology, Tashkent State Medical University, Tashkent, Republic of Uzbekistan
[2]Department of Pharmaceutical Chemistry, Tashkent Pharmaceutical Institute, Tashkent, Republic of Uzbekistan

Abstract. Plants of the genus *Paeonia* are considered promising sources of natural sedatives. Primarily, roots and rhizomes are used as medicinal raw materials for the treatment of neurasthenia, neurosis, hypochondria, and insomnia. This study aimed to determine the quality of medicinal peony (*Paeonia officinalis* L.) introduced into Uzbekistan, based on parameters such as appearance, colour, odour, particle size, and overall quality. In addition, amino acid, vitamin, polysaccharide, flavonoid, and elemental compositions of the raw material were identified and quantitatively determined using advanced analytical methods. The results confirmed the quality and safety of the raw materials. Polysaccharide composition was represented by fructose, glucose, sucrose, and maltose. Water-soluble vitamins identified included ascorbic acid (C), thiamine (B1), riboflavin (B2), nicotinic acid (PP), pyridoxine (B6), and folic acid (B9). Twenty free amino acids were detected with a total concentration of 13.692 mg/g, including eight essential amino acids, confirming the high biological value of the material. Flavonoids such as rutin, quercetin, salidroside, luteolin, dihydroquercetin, and rosavin were also quantified. The significant presence of biologically active compounds demonstrates the potential of developing effective pharmaceutical preparations from the roots and rhizomes of medicinal peony.

Keywords. Medicinal peony, Technological parameters, Quality assessment, HPLC, Amino acids, Flavonoids, Vitamins, Polysaccharides, Elemental composition.

*Corresponding author: zazulfiya@gmail.com

1 Introduction

Recently, there has been a sharp increase in recurrent disorders of the mental state of the adult population. The most common pathological conditions are depressive and generalised anxiety disorders and panic attacks. Depressive disorder is characterised by prolonged low mood and loss of interest in everyday activities. Generalised anxiety disorder involves persistent anxiety and excessive worrying. A panic attack is a sudden episode of extreme anxiety accompanied by autonomic manifestations such as sweating, palpitations and shortness of breath. Sedatives, tranquillisers and antidepressants are used to prevent these conditions, improve nervous system function, and reduce the risk of complications. Since therapy often requires a long time, safety and good tolerability are of great importance [1].

The use of synthetic drugs for CNS disorders is often associated with undesirable effects, including impaired memory and concentration, metabolic changes, hormonal disruptions, excessive sleepiness and dependence. This, in turn, limits the use of synthetic medications. In this regard, herbal remedies are attracting attention for the treatment of anxiety and depression. Plants of the genus *Paeonia* are among the promising sources for obtaining sedatives, with effects based on the balanced interaction of a complex of biologically active substances that have evolutionary affinity with the human body [2–4].

Creation of a phytopreparation based on ecologically pure medicinal raw materials of peony (*Paeonia officinalis* L.), having mild action without undesirable effects and not causing dependence, seems very important. The roots and rhizomes of *Paeonia officinalis* contain essential oils with methyl salicylate; free acids (benzoic and salicylic acids); glycoiridoids (peoniflorin, albiflorin); salicin; alkaloids; tannins; free amino acids; vitamins; polysaccharides; flavonoids; macro- and microelements; and saponins. To develop highly effective medicines from this plant, it is necessary to determine the quality of the plant raw materials of medicinal peony (*Paeonia officinalis* L.) [3–5].

Determination of technological parameters and quality of medicinal plant raw materials was carried out for the development of phyto-tea based on *Paeonia officinalis* L. Identification and quantitative determination of amino acid, vitamin, polysaccharide, flavonoid and elemental composition were performed.

2 Methodology

Identification of amino acids, vitamins, and flavonoids in peony raw material was performed by HPLC using an Agilent 1200 system, following previously described protocols [6–8, 11, 18, 19]. Polysaccharides were analyzed using an Agilent 1100 chromatograph. Standard solutions were prepared at 1 mg/ml, and an acetate buffer–acetonitrile system was used as the mobile phase. Heavy metals were determined using ICP-MS (NEXION-2000) with validated spectrometric techniques [18, 19]. Chromatographic methods were referenced to previous works, including Sinha et al. [11] and Patra et al. [17], which describe similar applications of chromatography for plant matrices.

3 Results

Dried raw material of roots and rhizomes of *Paeonia officinalis* L. was chopped on a root cutter and sieved through a set of sieves with diameters of 1 mm, 2 mm, 3 mm, 5 mm, and 7 mm. Material sieved to 2–3 mm was optimum for packing in filter bags. For bulk ("angro") packaging, raw material sieved to 7 mm was optimum.

In determining organoleptic parameters, the appearance was pieces of roots and rhizomes (2–3 mm); colour—brownish-yellow with brown flecks; odour—peculiar; taste—slightly bitter-sour. Infusion values were obtained by soaking in distilled water (1:10). Moisture content was measured on a moisture meter. The fraction of extractive substances was determined by repeated extraction, followed by evaporation, drying and weighing 100 ml of the liquid extract. Total ash was measured by calcining the sample in a muffle furnace at 600–800 °C for 2–3 h until complete burnout of organics. Ash content was calculated from the difference in crucible mass before and after calcination. The obtained technological parameters of medicinal plant raw material of roots and rhizomes of medicinal peony (Paeónia officinális L.) are given in Table 1.

Table 1. Results of determination of technological parameters of medicinal plant raw materials of roots and rhizomes of medicinal peony (Paeónia officinális L.).

Name of indicators **Surface of the raw material**	**Norms** Dry, non-sticky	**Results** Dry, non-sticky
Tincture	Bright, transparent, brownish brown.	Bright, transparent, brownish brown.
Mass fraction of moisture, % not more than	14	13-13,06
Mass fraction of water-soluble extractive substances, % not less than %	20	25
Mass fraction of metallomagnetic impurity g, not more than	0,0005	0,0005
External impurity content	Not allowed	-
Mass fraction of total ash, % not more	13	11,1-11,7

To determine quality, we measured moisture, ash, and extractives; ash insoluble in hydrochloric acid (characterising silica impurities) was also assessed [4,5]. (Table 2)

Table 2. Numerical parameters of raw materials of medicinal peony (*Paeónia officinális L.*)

Numerical indicators	**% in terms of absolutely dry raw material**
Moisture, %	13,3±0,3
Cinder, %	11,4±0,3
Cinder insoluble in HCl, %	2,1±0,1
Organic impurities, %	0,7±0,04
Mineral impurities, %	0,6±0,03

For metal content, a 0.5000 g sample was weighed; concentrated nitric acid and hydrogen peroxide were added; sealed autoclaves were treated in a Berghof microwave oven (MWS-3+). After decomposition, solutions were transferred to 50 ml volumetric flasks and diluted with 0.5% nitric acid. The instrument computed metal concentrations (mg/kg or μg/g) with RSD (%). (Table 3)

Table 3. Results of quantitative analysis of the mass fraction of metals in the raw material of medicinal peony (*Paeónia officinális L.*)

№	**The elements**	**Contents**	**№**	**The elements**	**Contents**
1	Li	0,982	18	Mn	11,1
2	Be	<0,05	19	Fe	158
3	Ca	9070	20	Co	0,347
4	Na	1600	21	Ni	11,0
5	Mg	2519	22	Zn	28,2
6	Al	54,0	23	Ga	0,038
7	Au	<0,05	24	As	0,328
8	K	10463	25	Se	1,06

9	Ba	10,6	26	Rb	2,02
10	Sc	0,184	27	Sr	94,9
11	Ti	33,3	28	Y	<0,10
12	Cr	5,03	29	Nb	0,019
13	Cd	0,119	30	Mo	0,617
14	La	0,034	31	Ce	0,073
15	Pr	<0,01	32	Nd	0,029
16	Pt	<0,05	33	Ag	<0,05
17	Pb	1,01	34	Th	0,014

Polysaccharides were analysed in isocratic mode. The mobile phase (acetonitrile:water = 82:18) ensured separation; flow 1.0 ml/min; injection 10 µl; column 35 °C. Retention times (standards): maltose 12.1 ± 0.2 min; sucrose 10.4 ± 0.2 min; glucose 5.7 ± 0.2 min; fructose 4.9 ± 0.2 min.

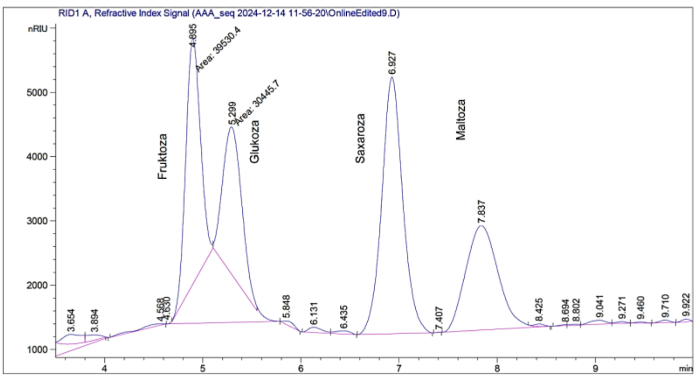


Fig. 1. Chromatogram of standard samples of monosaccharides

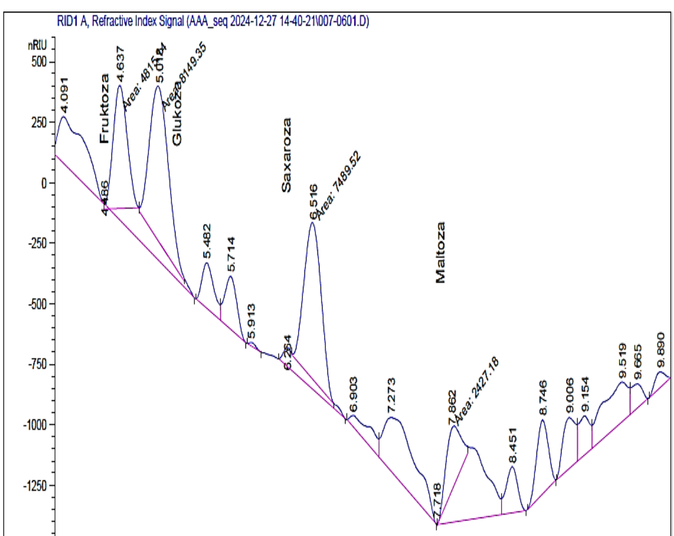


Fig. 2. Chromatogram of polysaccharide composition of raw material of medicinal peony (Paeónia officinális L.)

The polysaccharide composition was represented by fructose (2.053 mg/g), glucose (3.718 mg/g), sucrose (2.938 mg/g), and maltose (1.253 mg/g).

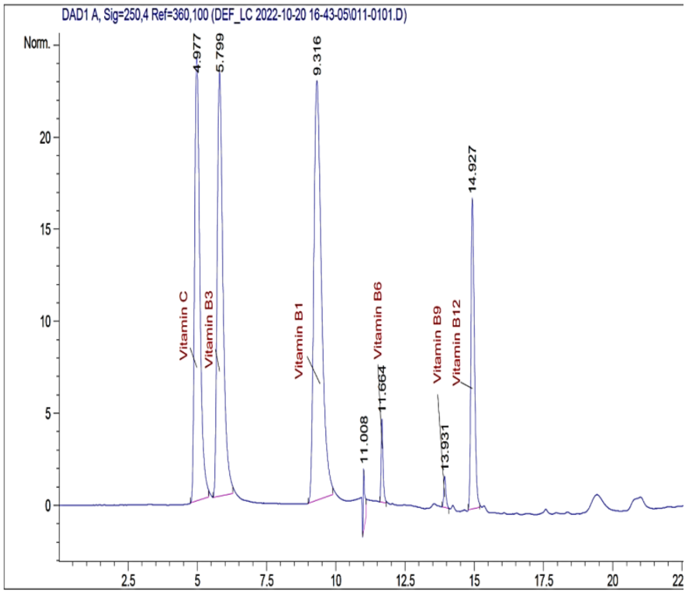


Fig. 3. Chromatogram of standard samples of water-soluble vitamins

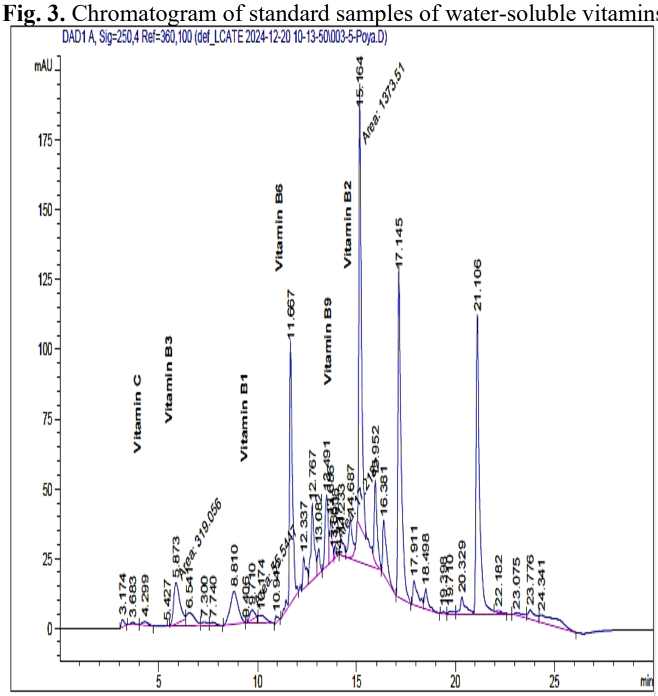


Fig. 4. Chromatogram of vitamin composition of raw materials of medicinal peony (*Paeónia officinális L.*)

Water-soluble vitamins were analysed by HPLC: ascorbic acid 10.8 mg/g; B1 5.66 mg/g; B2 14.2 mg/g; PP 10.35 mg/g; B6 19.5 mg/g; B9 9.84 mg/g.
For free amino acids, proteins/peptides were removed by centrifugation after adding 20%

trichloroacetic acid (1:1, v/v), centrifuged at 8000 rpm for 15 min. An aliquot (0.1 ml) was lyophilised; the hydrolysate was evaporated; residue dissolved in triethylamine–acetonitrile–water (1:7:1) and dried (twice) to neutralise acid. PTC derivatives were prepared by reaction with phenylisothiocyanate following Steven A., Cohen Daniel [7,9,10]. Twenty free amino acids were identified; total 13.692 mg/g, including eight essential amino acids. The results for the composition and amount of amino acids are presented in Table 4, chromatograms of standard and raw materials are shown in Fig. 5 and Fig. 6.

Table 4. Composition of free amino acids in the raw material of roots and rhizomes of medicinal peony (*Paeónia officinális L.*)

№	***Name of amino acids***	**Concentration mg/g**	***Concentration %***
1	Asparagine acid	0,651	*4,75*
2	Glutamic acid	0,451	*3,29*
3	Serine	0,503	*3,67*
4	Glycine	0,156	*1,14*
5	Asparagine	0,143	*1,04*
6	Glutamine	0,082	*0,60*
7	Cysteine	0,077	*0,56*
8	Thrionine*	0,657	*4,80*
9	Arginine	0,047	*0,34*
10	Alanine	0,419	*3,06*
11	Proline	1,116	*8,15*
12	Tyrosine	1,233	*9,00*
13	Valine*	0,540	*3,94*
14	Methionine*	0,309	*2,26*
15	Histidine*	0,898	*6,56*
16	Isoleucine*	0,245	*1,79*
17	Leucine*	2,278	*16,64*
18	Tryptophan	0,202	*1,47*
19	Phenylalanine*	3,479	*25,41*
20	Lysine*	0,204	*1,49*
Total		**13,692**	***100%***
Total concentration of essential amino acids		**8,61**	***62,88***

As can be seen from the table, 20 free amino acids were studied and identified, the quantitative content of which was 13.692 mg/g of which 8 are essential amino acids.

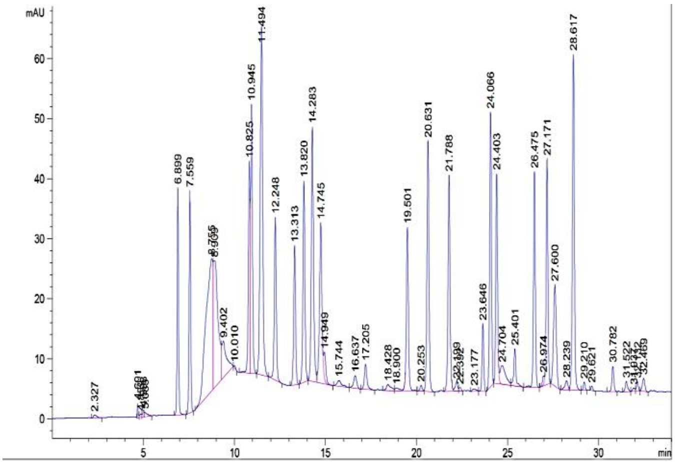


Fig. 5. Chromatogram of a standard sample of free amino acids

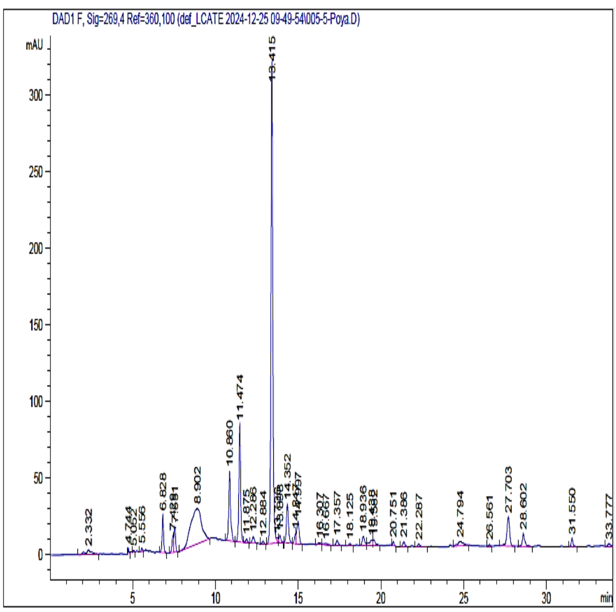
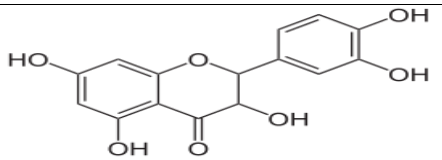
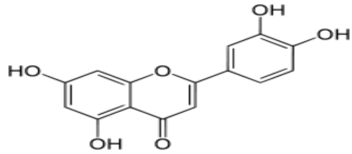
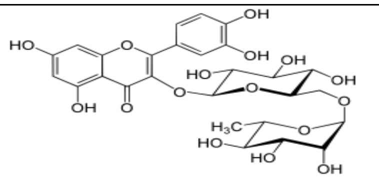
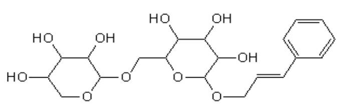
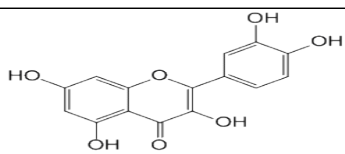
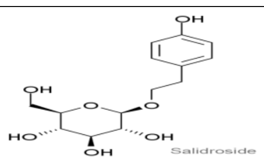


Fig. 6. Chromatogram of amino acid composition of raw materials of roots and rhizomes of medicinal peony (*Paeónia officinális L.*)

Flavonoids were quantified using phosphate buffer–acetonitrile as the eluent, following methods in [5,7,11–14]. Identified flavonoids included rutin, quercetin, salidroside, luteolin, dihydroquercetin and rosavin.

A system of phosphate buffer and acetonitrile was used as eluent. The data of quantitative determination of flavonoids of medicinal peony raw material are given in Table 5. The chromatograms of the standard sample of dihydroquetin are shown in Fig.7, luthiolin in Fig.8, rutin in Fig.9, rosavin in Fig.10, quercetin in Fig.11, salidroside in Fig.12. Chromatograms of raw materials of roots and rhizomes of medicinal peony (Paeónia officinális L.) are shown in Fig 13.

Table 5. Results of quantitative determination of flavonoids contained in the raw material of roots and rhizomes of medicinal peony (*Paeónia officinális L.).*

№	Flavonoids	Concentration mg/g
1	Dihydroquercitin 	0.77
2	Luthiolin 	0.54
3	Rutine 	0.45
4	Rosavin 	5.91
5	Quercitin 	0.133
6	Salidroside 	42.61

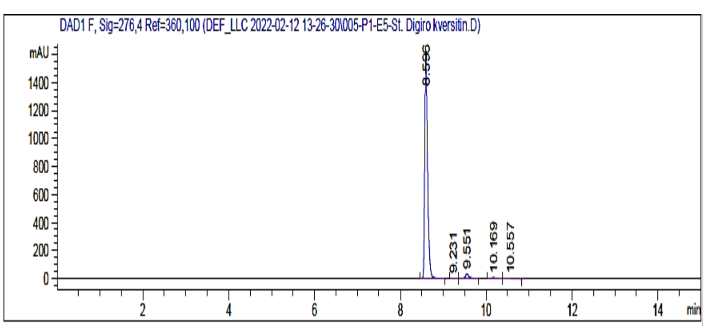


Fig. 7. Chromatogram of a standard sample of dihydroquercitin

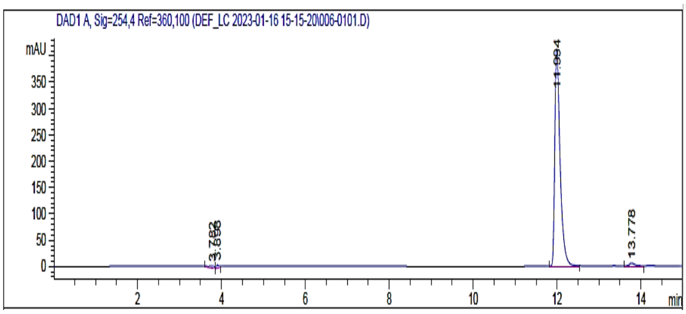


Fig. 8. Chromatogram of a standard sample of luthiolin

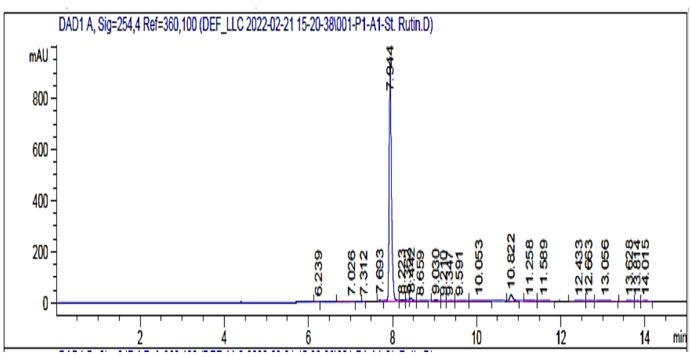


Fig. 9. Chromatogram of a standard sample of rutin

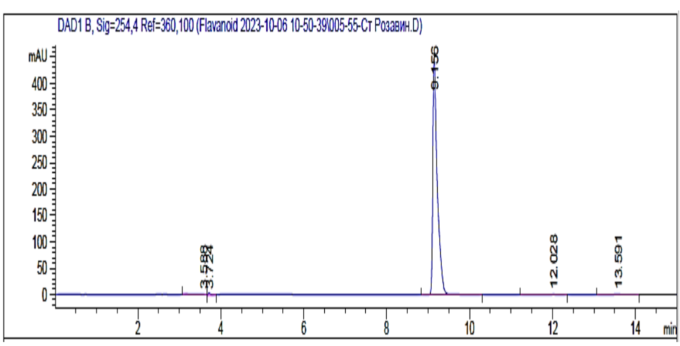


Fig. 10. Chromatogram of a standard sample of rosavin

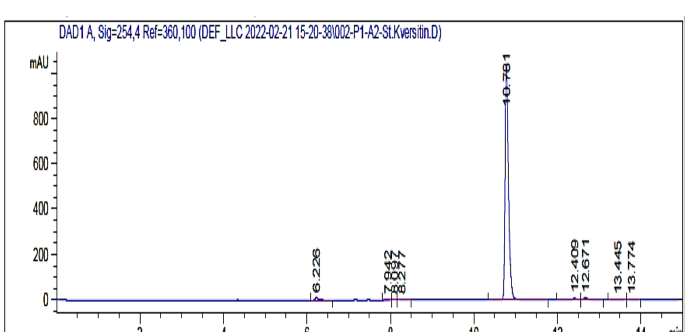


Fig. 11. Chromatogram of a standard sample of quercetin

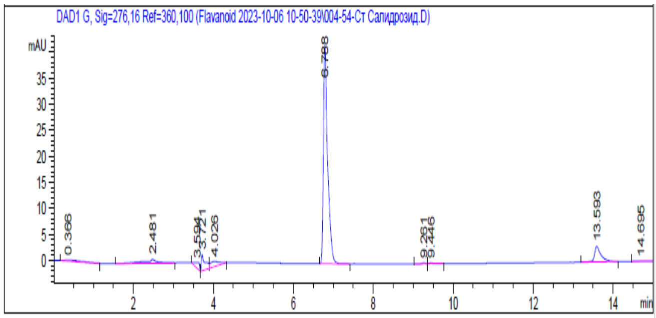


Fig. 12. Chromatogram of a standard sample of salidroside

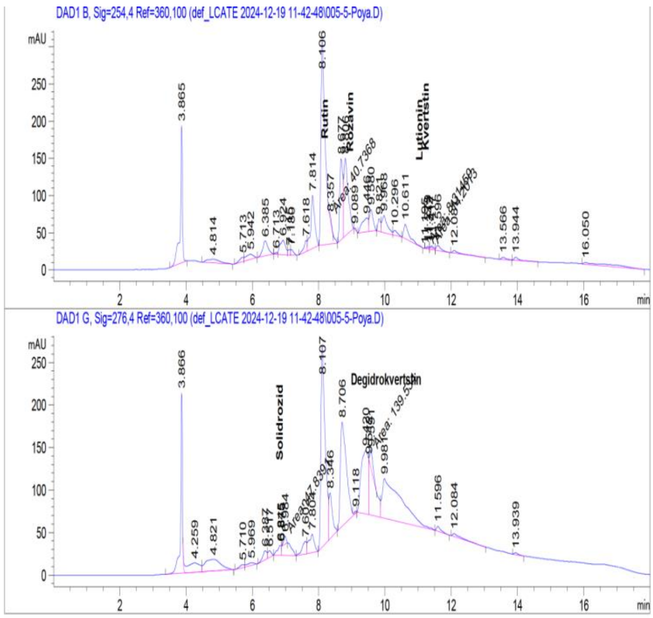


Fig. 13. Chromatogram of the dry extract of medicinal peony (*Paeónia officinális*)

4 Discussion

Dried roots and rhizomes of medicinal peony (*Paeonia officinalis* L.) were ground with a root cutter. Raw material sieved to 2–3 mm was found optimal for filter bag packaging, while 7 mm fractions were most suitable for bulk packaging.

The organoleptic parameters of the raw material were assessed. The appearance consisted of root and rhizome pieces with a diameter of 2–3 mm. The colour was brownish-yellow with brown flecks. The raw material had a characteristic odour and a slightly bitter-sour taste.

Infusion properties were measured by soaking in distilled water at a ratio of 1:10. Moisture content was measured using a moisture meter. The mass fraction of extractive substances was determined by repeated extraction, followed by evaporation, drying, and weighing of 100 ml of the liquid extract. The total ash content was determined by calcining the sample in a muffle furnace at 600–800 °C for 2–3 hours, until the organic matter was completely burned, as indicated by the absence of black particles. Ash content was calculated from the difference in crucible mass before and after calcination.

The overall quality of *Paeonia officinalis* raw material was established. The polysaccharide, vitamin, amino acid, and flavonoid compositions were identified and quantified. The polysaccharide composition, determined using an Agilent 1100 liquid chromatograph equipped with a G1379A degasser, included fructose, glucose, sucrose, and maltose.
The vitamin profile was analysed by HPLC on an Agilent 1200 series system. The following water-soluble vitamins were identified and quantified: ascorbic acid, thiamine, riboflavin, nicotinic acid, pyridoxine, and folic acid.
Amino acid derivatives were analysed by HPLC on an Agilent 1200 chromatograph with a DAD detector and a Discovery HSC18 column (75 × 4.6 mm). Twenty free amino acids were identified, including eight essential ones, confirming the high biological value of peony roots and rhizomes.
Flavonoids were quantified using an Agilent 1200 system with phosphate buffer–acetonitrile as the mobile phase. The identified flavonoids included rutin, quercetin, salidroside, luteolin, dihydroquercetin, and rosavin.

5 Conclusion

Qualitative and numerical parameters of the roots and rhizomes of medicinal peony (*Paeonia officinalis* L.) were determined, including appearance, colour, odour, particle size, total ash, ash insoluble in hydrochloric acid, organic and mineral impurities, as well as the quantitative content of metals.
The quality of the raw material was confirmed, and the polysaccharide, vitamin, amino acid, and flavonoid compositions were identified and quantified. The polysaccharide profile included fructose, glucose, sucrose, and maltose.
Water-soluble vitamins such as ascorbic acid (C), thiamine (B1), riboflavin (B2), nicotinic acid (PP), pyridoxine (B6), and folic acid (B9) were detected in the roots and rhizomes.
A total of 20 free amino acids were identified, with a total content of 13.692 mg/g, including eight essential amino acids, indicating the high biological value of the raw material.
Flavonoids such as rutin, quercetin, salidroside, luteolin, dihydroquercetin, and rosavin were also detected. The high content of biologically active substances highlights the potential of *Paeonia officinalis* roots and rhizomes for the development of effective pharmaceutical forms and phyto-tea preparations.

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