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WATER-SOLUBLE VITAMINS OF CALENDULA OFFICINALIS, PRUNUS DULCIS AND ERIOBOTRYA JAPONICA QUANTITATIVE ANALYSIS PRACTICAL SIGNIFICANCE

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Annotation
Water-soluble vitamins of medicinal plants were studied using HPLC. It was found that Prunus dulcis stem bark is rich in B2 (5.25 mg/100 g) and B9 (3.35 mg/100 ml), Eriobotrya japonica leaves contain vitamin C (166.4 mg/100 g), and Calendula officinalis flowers are rich in B6 (3.26 mg/100 g), B12 (3.71 mg/100 g), and PP (2.21 mg/100 g). The results indicate that the combined use of these three plants is promising for the development of biologically active supplements.

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Introduction. In recent years, there has been a growing global interest in herbal-based preparations and biologically active supplements. The main reasons for this include their natural origin, wide availability, and rich content of biologically active compounds such as flavonoids, polyphenols, alkaloids, organic acids, minerals, and especially vitamins [1]. Preparations obtained from medicinal plants are, in many cases, considered safer compared to synthetic drugs, suitable for long-term use, and distinguished by their complex biological activity [2].

In this regard, water-soluble vitamins hold a special place. According to most sources, ascorbic acid (vitamin C) and B-group vitamins (B_1, B_2, B_6, B_9, B_{12}, and PP) play a crucial role in

human health. They participate in antioxidant defense, hematopoiesis, immune system support, and the metabolism of proteins, fats, and carbohydrates. For example, vitamin C plays an important role in collagen synthesis and protection against oxidative stress, while B-group vitamins are essential for the functioning of the nervous system and serve as indispensable coenzymes in cell division. Therefore, studying the vitamin composition of medicinal plants has both theoretical and practical significance.

Among medicinal plants, Calendula officinalis (marigold), Prunus dulcis (sweet almond), and Eriobotrya japonica (loquat) deserve special attention due to their widespread use in folk medicine and pharmaceutical practice. Scientific sources indicate that their chemical composition is characterized by specific features [3]. Literature reports state that Calendula officinalis flowers are rich in flavonoids, carotenoids, polysaccharides, saponins, essential oils, and organic acids, whose combination provides antioxidant, anti-inflammatory, wound-healing, and immunomodulatory effects [4–9]. Prunus dulcis has been shown to contain flavonoids, phenolic compounds, fats, organic acids, and is also rich in minerals [10, 11]. The leaves of Eriobotrya japonica, in addition to phenolic compounds, triterpenes, and flavonoids, are well known for their high ascorbic acid content, which underlies their antioxidant and immunomodulatory properties [12, 13].

Nevertheless, analysis of the available literature shows that the chemical composition of these plants has mostly been studied separately. For each species, data on vitamin content and biological activity have been presented, but their compositional analysis, comparative vitamin profiling, and pharmacological potential have not been sufficiently investigated in combination.

Thus, the comparative study of water-soluble vitamins in Calendula officinalis, Prunus dulcis, and Eriobotrya japonica and the assessment of their compositional significance represent an important scientific and practical task. Such research opens up opportunities for the development of biologically active supplements, phytopreparations, and functional beverages.

Materials and Methods

Sample collection. For this study, plants cultivated in the Fergana region of Uzbekistan were used: flowers of Calendula officinalis, stem bark of Prunus dulcis, and leaves of Eriobotrya japonica. Raw materials were collected in May–June. Each plant was botanically identified.

Sample preparation. The collected raw materials were dried at 40–45 °C, ground with a mechanical grinder, and sieved (particle size ≤1 mm).

Extraction. From each sample, 10 g was extracted in 100 ml of distilled water at 60 °C for 2 hours in a water bath. The obtained extract was filtered and prepared for HPLC analysis. Each experiment was repeated three times (n = 3).

Determination of water-soluble vitamins. Vitamins were analyzed using high-performance liquid chromatography (HPLC) in gradient elution mode with a diode-array detector (DAD). Acetonitrile and buffer solution were used as the mobile phase. Spectral data were recorded in the range of 200–400 nm.

Chromatographic conditions:

Chromatograph: Agilent Technologies 1260

Column: Eclipse XDB – C18, 5.0 μm, 4.6 × 250 mm

Mobile phase (gradient mode):

0–6 min: acetonitrile – buffer solution pH=2.92 (4% : 96%)

6–9 min: (10% : 90%)

9–15 min: (20% : 80%)

15–20 min: (4% : 96%)

Injection volume: 10 μl

Flow rate: 0.75 ml/min

Detector: DAD, λ = 272, 292, 254, 297, 360 nm [14]

Statistical analysis. Each measurement was carried out in triplicate. Results are presented as mean ±

Results and Discussion

During the study, the water-soluble vitamin content of Calendula officinalis flowers, Prunus dulcis stem bark, and Eriobotrya japonica leaves was determined using HPLC (Fig. 1). The obtained results showed that the distribution of vitamins varied significantly depending on the plant species (Table 1).

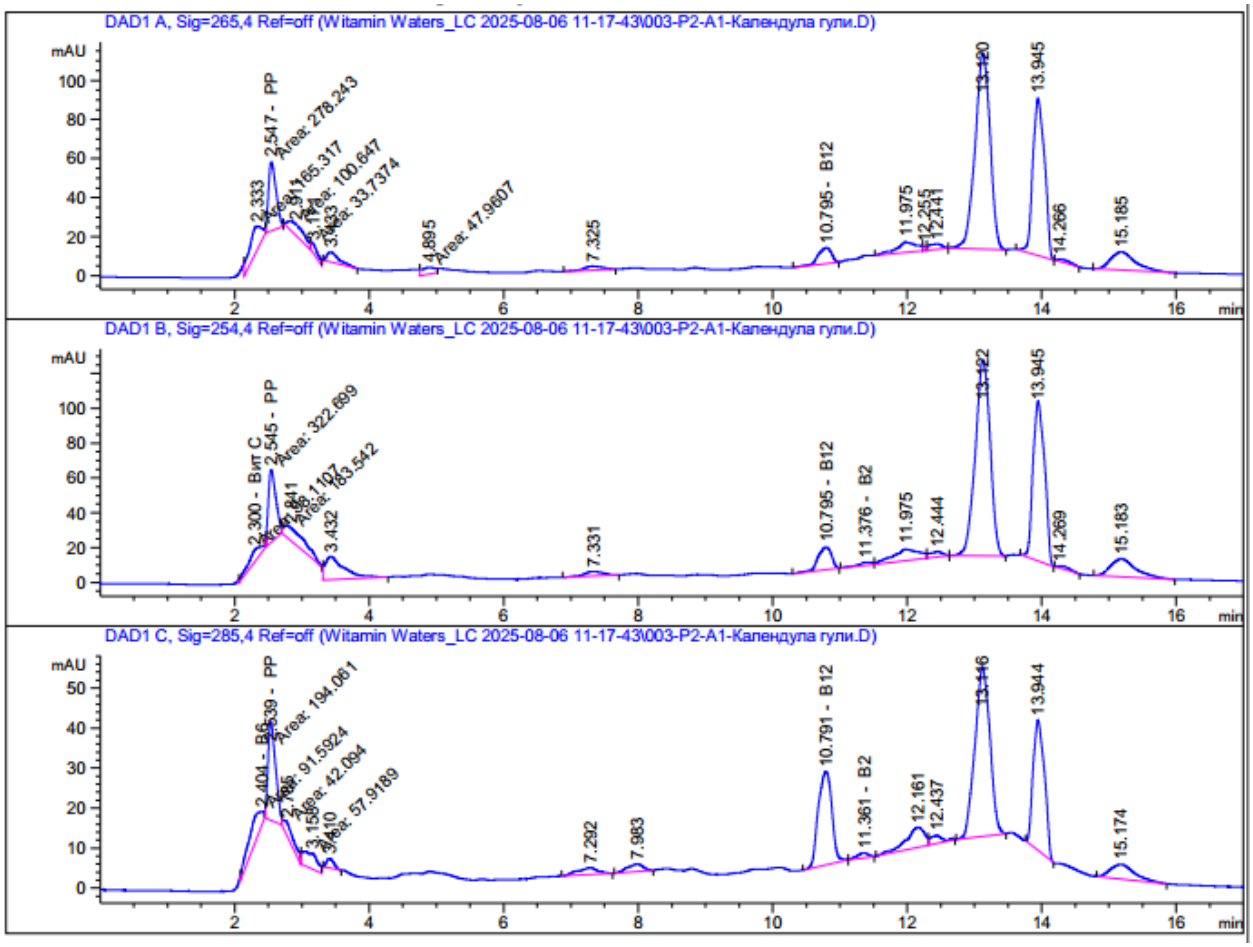


Fig.1. Chromatograms of vitamins from flowers Calendula officinal's

Table 1

Content of water-soluble vitamins in the studied plants (mg/100g)

№	Vitamins	Calendula officinalis	Prunus dulcis	Eriobotrya japonica
1	B_1	3,253	3,825	3,83
2	B_2	1,124	5,251	1,182
3	B_6	3,263	1,124	2,877
4	B_9	0,352	3,352	0,359
5	B_{12}	3,712	1,987	0,628
6	PP	2,211	0,251	0,502
7	C	23,311	48,308	166,447

The graph of vitamins distribution in the studied plants is shown in the figure 2.

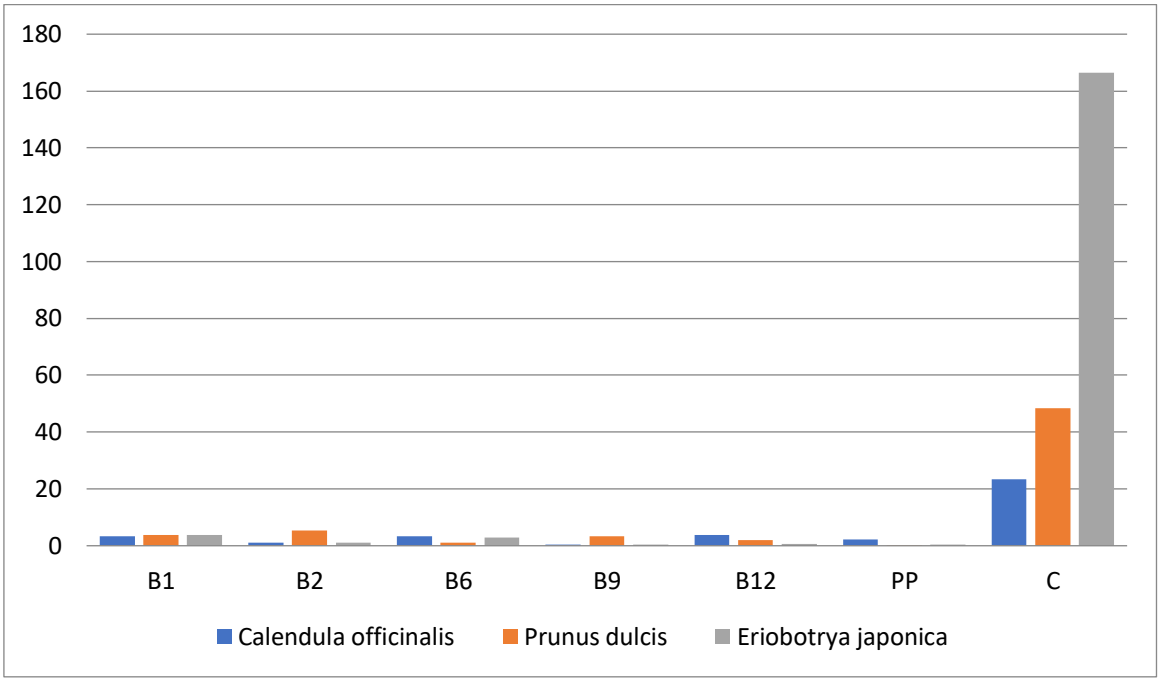


Fig. 2. Distribution of vitamins in the studied plants

As shown in Figure 2, the leaves of Eriobotrya japonica represent the richest source of vitamin C, with a content of 166.447 mg/100 g. This value is approximately 7.1 times higher than in Calendula officinal's flowers (23.325 mg/100 g) and 3.4 times higher than in Prunus dulcis stem bark (48.308 mg/100 g). These findings confirm the strong antioxidant activity of E. japonica leaves. Ascorbic acid plays a central role in immune support, collagen synthesis, and anti-inflammatory processes. Therefore, extracts from E. japonica leaves are considered highly promising for the development of antioxidant and immunomodulatory preparations.

The thiamine (B_1) content in E. japonica leaves was 3.825 mg/100 g, almost equal to that in P.dulcis bark (3.253 mg/100 g). In C. officinal's flowers, vitamin B_1 was not detected. Thiamine functions as a key coenzyme in carbohydrate metabolism and the central nervous system. Thus, both E.japonica leaves and P.dulcis's bark may exert neuroprotective effects.

With regard to vitamin B_2, P.dulcis's bark showed the highest level (5.251 mg/100 g), compared to 1.182 mg/100 g in E. japonica leaves and 0.985 mg/100 g in C. officinalis flowers. Riboflavin serves as a crucial coenzyme in redox reactions and energy production. Hence, P. dulcis bark may be regarded as a natural source for stimulating energy metabolism.

In terms of vitamin B_6, C. officinal's flowers contained the highest amount (3.258 mg/100 g), followed by E. japonica leaves (2.877 mg/100 g), while P. dulcis bark showed only 1.124 mg/100 g. Vitamin B_6 is an essential coenzyme in protein and amino acid metabolism. Therefore, the anti-inflammatory and regenerative effects of C.officinalis may be associated with its high pyridoxine content.

Vitamin B_9 was most abundant in P. dulcis bark (3.352 mg/100 ml). Its content was 0.359 mg/100 g in E. japonica leaves, whereas it was not detected in C. officinal's flowers. Folates play a critical role in DNA synthesis and cell division, suggesting that P. dulcis bark may serve as an important biological source during hematopoiesis and pregnancy.

The highest vitamin B_{12} level was found in C. officinalis flowers (3.712 mg/100 g), significantly exceeding that of P. dulcis stem bark (1.987 mg/100 ml) and E. japonica leaves (0.628 mg/100 g). Cobalamin is vital for nerve fiber formation and hematopoiesis, which explains the biotonic effects of calendula flowers.

Similarly, vitamin PP was most abundant in C. officinalis flowers (2.213 mg/100 g), compared to 0.502 mg/100 g in E. japonica leaves and 0.251 mg/100 ml in P. dulcis stem bark. Niacin is a major coenzyme in energy metabolism and plays a crucial role in the human body.

Thus, the combination of these three plants provides a complete vitamin complex. This highlights their potential as raw materials for folk medicine as well as for the production of biologically active supplements and phytopreparations.

Conclusion. The study revealed that Eriobotrya japonica leaves are rich in vitamin C, Prunus dulcis stem bark contains high levels of B_2 and B_9, and Calendula officinalis flowers are abundant in B_6, B_{12}, and PP, which define their biological activity. Comparative analysis confirmed consistency with literature and, for the first time, provided a comprehensive vitamin profile of all three plants together. These findings form a scientific basis for the development of phytopreparations and dietary supplements.

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