CZU: 582.998.4:581.19:547.562

DYNAMICS OF THE ACCUMULATION OF PHENOLIC COMPOUNDS IN TARAXACUM OFFICINALE ROOTS, LEAVES AND FLOWERS

DINAMICA ACUMULĂRII COMPUȘILOR FENOLICI ÎN RĂDĂCINI, FRUNZE ȘI FLORI DE PĂPĂDIE

Viktoryia Tsiarletskaya, Raman Lukashou

Belarusian State Medical University, Minsk, Republic of Belarus

Rezumat. A fost cercetată dependența conținutului de compuși fenolici din rădăcini, flori și frunze de *Taraxacum officinale* de perioada de colectare a materiei prime. Cel mai mare conținut de compuși fenolici a fost înregistrat în toate organele de *T. officinale* în fazele de început și de înflorire în masă (sfârșitul lunii aprilie – începutul lunii iunie). Această perioadă este recomandată pentru colectarea întregii plante. Acest lucru va face posibilă obținerea materiilor prime cu un conținut ridicat de compuși fenolici și va asigura prelucrarea fără deșeuri a materiilor prime.
Cuvinte cheie: *Taraxacum officinale*, compuși fenolici, dinamica acumulării.
Abstract. The dependence of the content of phenolic compounds in the roots, flowers and leaves of Taraxacum officinale on the period of raw material procurement has been investigated. The highest content of phenolic compounds was recorded in all organs of T. officinale in the phases of the beginning and mass flowering (late April – early June). This period is recommended for harvesting the entire plant. This will make it possible to obtain raw materials with a high content of phenolic compounds and ensure waste-free processing of raw materials.
Keywords: Taraxacum officinale, phenolic compounds, accumulation dynamics.

INTRODUCTION

The phenolic compounds of the *Taraxacumofficinale* include flavonoids (quercetin, isorhamnetin, luteolin and their glycosides), phenolic acids (chlorogenic, caffeic, chicory, gallic acids), leukoanthocyanidins, catechins [1], coumarins (esculetin, cichoriin) [2].

This group of substances exhibits a variety of biological activities. Extracts from Common dandelion flowers, containing luteolin and cynaroside, absorb DPPH radicals and protect DNA from damage by hydroxyl radicals [3]. Extracts of the aerial part of plant with a high content of phenolic compounds exhibit anticoagulant activity and inhibit lipid peroxidation in platelets [4]. Dandelion polyphenols protect against acetaminophen-induced hepatotoxicity in mice [5]. In studies on rats, extracts enriched with phenolic acids have been shown to reduce triglyceride and total cholesterol levels in the blood [6]. The hypoglycemic effect of *T.officinale* is associated with chlorogenic acid [3]. In vitro experiments established the effectiveness of phenolic compounds of dandelion against Herpes simplex virus 1 [2]. The inhibition of the growth of *S. aureus*, *K. pneumoniae*, *E. coli*, *P. mirabilis* in vitro is associated with the presence of phenolic compounds in the extracts [7].

It is known that the content of phenolic compounds in *T.officinale* depends on the place and year of harvesting [7]; however, there is no information on the dynamics of their accumulation in various plant organs during the growing season. This does not allow us to determine the optimal harvesting time for obtaining raw materials with a high content of biologically active substances.

MATERIALS AND METHODS

The roots, leaves, flowers of *T. officinale* were harvested from mid-April till mid-October every two weeks (except for flowers) and then subjected to air-shadow drying.

A sample of crushed raw materials weighing 0.200 g was extracted with ethyl alcohol with a concentration of 70% by volume for 120 minutes in a water bath at a temperature of 60°C and a ratio of raw materials and extractants of 1 to 50.

The content of phenolic compounds was determined by spectrophotometry. To 0.1 ml of the extract was added 0.15 ml of the Folin-Chocalteu reagent and 4.75 ml of 10% sodium carbonate solution, brought to 10.0 ml with purified water. After 30 minutes, the optical density of the solution was measured on a Solar spectrophotometer at a wavelength of 760 nm. A solution of 0.15 ml of Folin-Chocalteu's reagent, 4.85 ml of sodium carbonate, made up to 10.0 ml with purified water, was used as a compensation solution.

The recalculation was carried out by the method of the calibration graph for chlorogenic acid, which is the dominant phenolic compound of *T.officinale* [1].

RESULTS AND DISCUSSIONS

The content of phenolic compounds in the roots, leaves and flowers of *T.officinale* depends on the growing season.

The dynamics of the accumulation of phenolic compounds in the roots has a wave-like character (Figure 1).

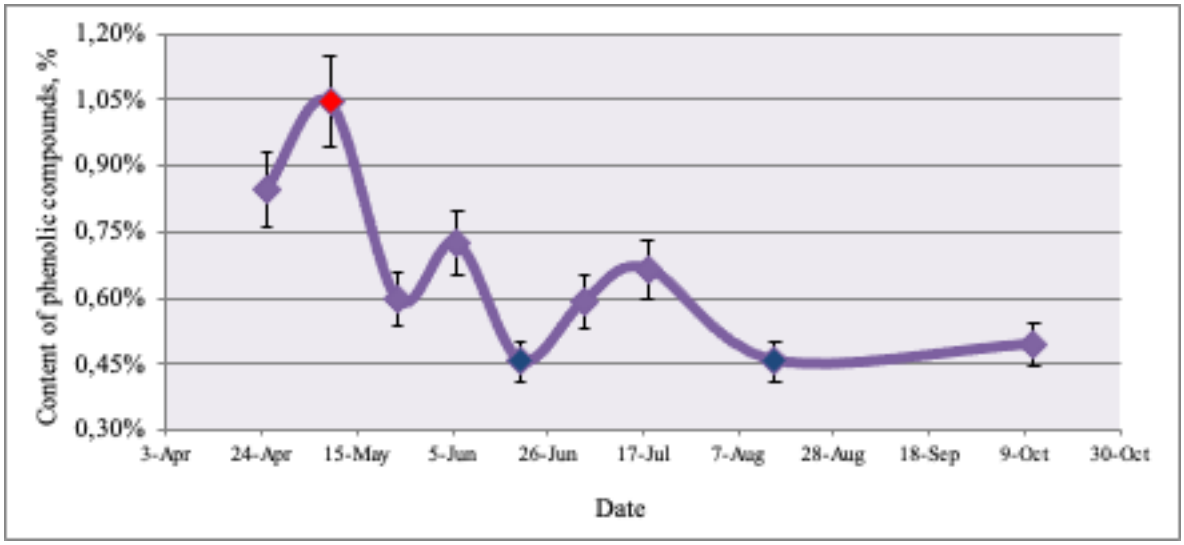

Figure 1. Dynamics of accumulation of phenolic compounds in roots

The highest value was recordedon May 9 – 1.05% (mass flowering), the minimum values –inJune 20 and August 15 – 0.46%. Harvesting during the withering away of the aboveground part in October, as is traditionally accepted, leads to a decrease in the content of phenolic compounds by 2.3 times on comparable withmass flowering (Table 1). After the main maximum during flowering, the content of phenolic compounds fluctuates slightly (from 0.46 to 0.73).

Table 1. Themiddle content of phenolic compounds in the roots

Date	25-Apr	09-May	24-May	06-June	20-June	04-Jule	18-Jule	15-August	11-October
Content, %	0.84	1.05	0.60	0.73	0.46	0.59	0.67	0.46	0.49

The variability of the content of phenolic compounds in the leaves, as in the roots, has a wavy appearance with a decrease towards the end of the growing season (Figure 2). The maximum at the beginning of plant development is due to the fact that phenolic compounds are synthesized in the aerial part, which is actively developing during this period. The content of phenolic compounds in the leaves remained at a high level (more than 5%) throughout the spring and the first half of summer.

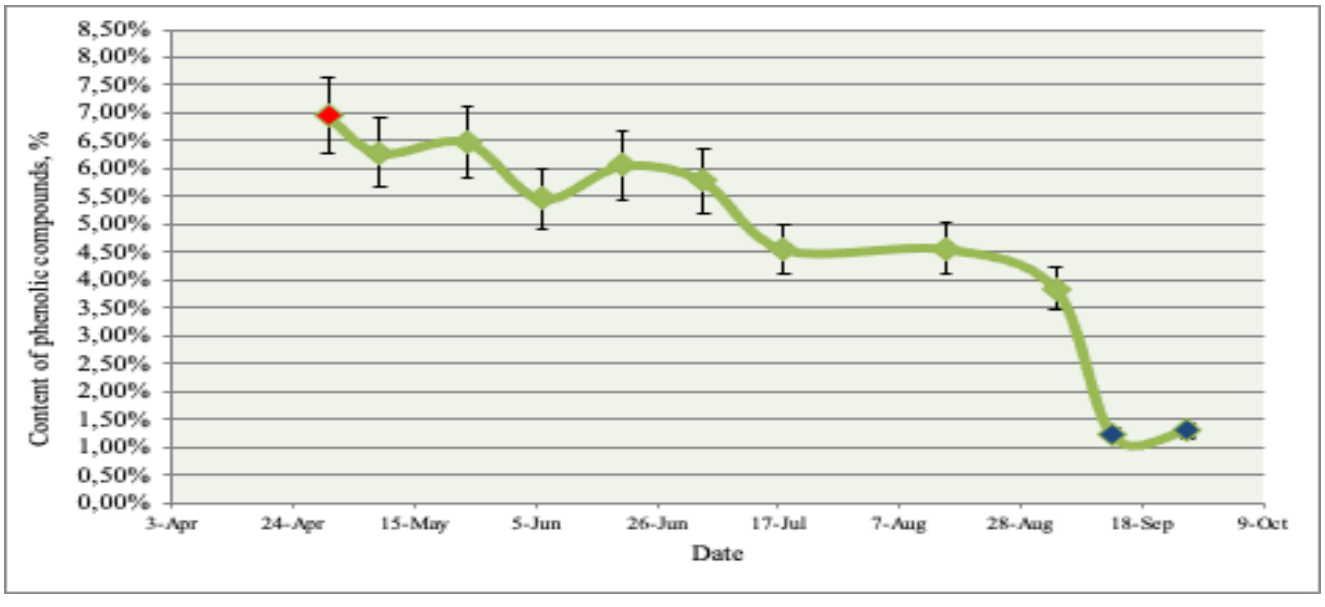

Figure 2. Dynamics of accumulation of phenolic compounds in leaves

The highest content of phenolic compounds was noted in the budding phase (April 30 – 6,95%), the minimum – in the dying off of the aboveground part (September 13 – 1.21%, September 26 – 1.30%). By the end of the growing season, the content of phenolic compounds in dandelion leaves decreased 5.5 times. If dandelion leaves are harvested before flowering, rather than traditionally during or after flowering, the content of phenolic compounds will increase by 1.3 times (Table 2). In the course of plant development, a gradual decrease in the content of phenolic compounds in the leaves is observed with the formation of a plateau.

Table 2. The middlecontent of phenolic compounds in the leaves

Date	30-April	9-May	24-May	6-June	20-June	4-Jule	18-Jule	15-August	3-September	13-September	26-Septemder
Content, %	6.95	6.29	6.49	5.46	6.06	5.78	4.55	4.56	3.85	1.21	1.30

Dandelion flowers were harvested in April and May. The content of phenolic compounds gradually increased from the budding phase to the mass flowering phase, after which it began to decrease (Figure 3).

The maximum value was noted in early May (4.65% on May 9), the minimum –in mid-April (23% on April 23). By the period of mass flowering, the content of phenolic compounds in flowers increased by 1.25 times (Table 3).

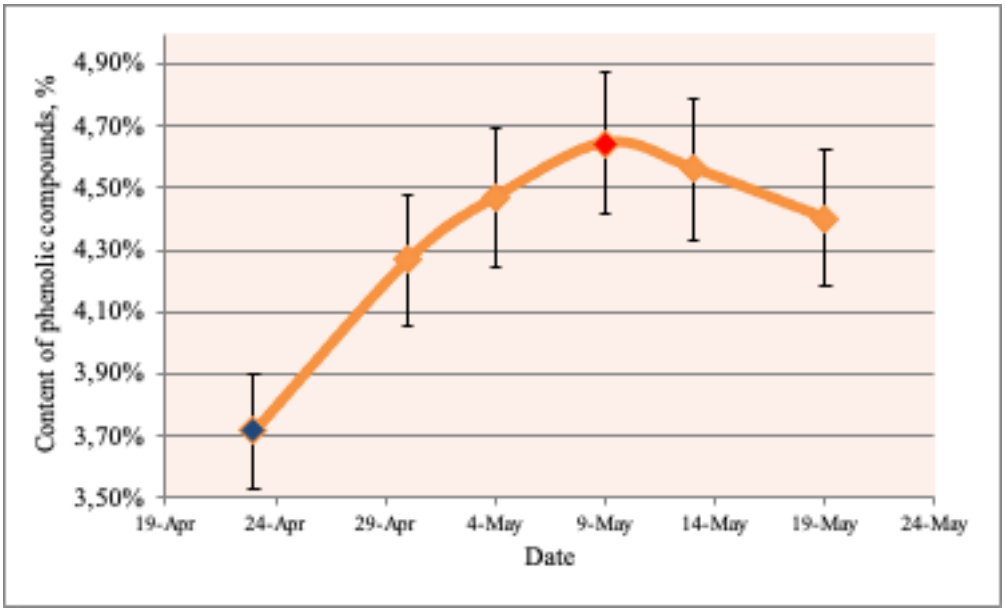

Figura 3. Dynamics of accumulation of phenolic compounds in flowers

Table 3. The middlecontent of phenolic compounds in flowers

Date	23-April	30-April	4-May	9-May	13-May	19-May
Content, %	3.72	4.27	4.47	4.65	4.56	4.40

The highest content of phenolic compounds is shown by dandelion leaves at the budding phase– 6.95%, which is 1.6 times more than the maximum content in flowers and 6.9 times more than the maximum content in the roots.

Redistribution of phenolic compounds between underground and aboveground parts is observed during the harvesting period. The maxima of the content of phenolic compounds in the aboveground part of the dandelion coincide with the minima in the underground part and vice versa. Thus, an increase in the content of phenolic compounds in the leaves on May 24, June 20, and August 15 was accompanied by its decrease in the roots. An increase in the content in the roots on May 9, June 6, and July 18 occurred simultaneously with a decrease in the concentration of phenolic compounds in the leaves (Figura 4). The maximum content in flowers falls on the minimum in the leaves.

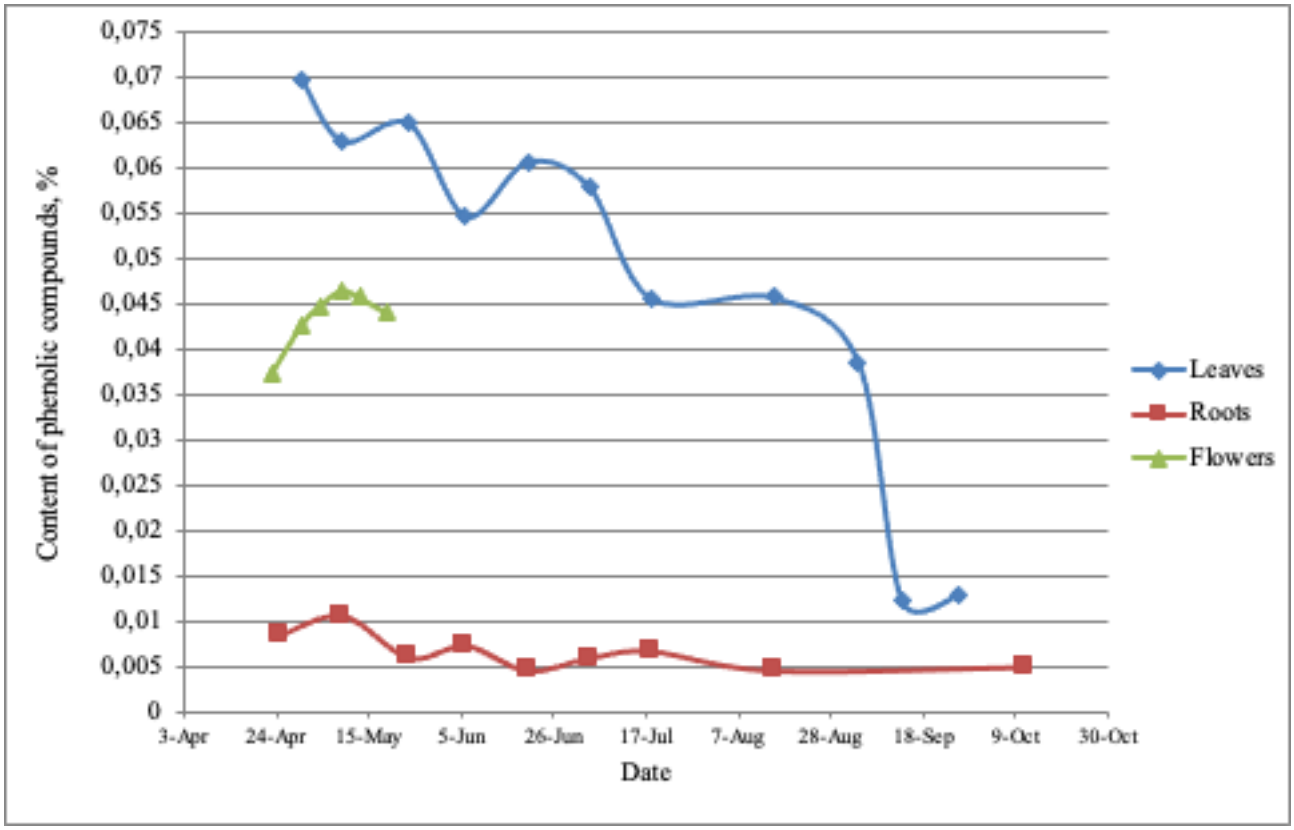

Figure 4. Commondynamics of accumulation of phenolic compounds in roots, flowers and leaves

In general, the roots, leaves and flowers of *T.officinale* contain the most phenolic compounds during the mass flowering (9 May), the budding phase (30 April) and mass flowering (9 May).

CONCLUSIONS

The highest content of phenolic compounds was shown by roots (1.05%) and flowers (4.65%) harvested in early May (mass flowering); leaves (6.95%), harvested at the end of April (the budding phase). By the end of the growing season, the content of phenolic compounds in the leaves decreased 5.5 times, in the roots – 2.3 times. The richest source of phenolic compounds are leaves: the content is 1.6 times higher than in flowers and 6.9 times higher than in roots.Thus, the period with the highest phenolic content in dandelion differs significantly from the traditional harvesting period. Concerning, it is necessary to revise its harvesting time.

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