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Investigation of macro-micronutrients, flavonoids, and vitamins contents of *Taraxacum officinale* L.

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Abstract

A leaf of *Taraxacum officinale* L. contains biologically active components are sesquiterpenic lactones, biotin, inositol and vitamins such as A, C, B, D, E and K. Leaves of *T. officinale* are rich in fiber, protein, and nutrients such potassium, iron, Fe and Ca phosphorus, calcium, and magnesium. The leaves can be eaten cooked or raw in various forms, for assembling salads or soup, which also recommended as a natural source of vitamin C in the early spring. It has been widely used for hepatitis, rheumatism, anti-inflammatory, antioxidative, anticarcinogenic, analgesic, antihyperglycemic, anticoagulatory, antioxidant, treat anemia, choleretic, diuretic, hepatoprotective and anti-inflammatory properties. The experimental results showed significantly higher content of total chlorophylls (3.79 mg/g), and carotenoids (3.85 mg/g) in leaves of *T. officinale* in the territory of the Chatkal State Biosphere Reserve. It was also found to contain four flavonoids such as rutin, gallic acid, hyperazide, and apigenin ranged from 83.432 to 16.041 mg/100 g; and four vitamins such B2, C, B12, and B9 ranged from 34.962 to 18.248 mg/100 g. Among the macroelements, there were significantly higher levels of potassium (K), calcium (Ca) and phosphorus (P), and significantly lower levels of magnesium (Mg), and sulphur (S). In the case of microelements, significantly greater iron (Fe), aluminium (Al), silicon (Si), barium (Ba), manganese (Mn) and zinc (Zn). microelements such as Fe, Al, Si, Ba, Mn, Zn, boron (B), copper (Cu), molybdenum (Mo), and chromium (Cr), ranged from 6.361 to 0.052 mg/g.

1. Introduction

Taraxacum officinale L. (G.H. Weber ex Wiggers), commonly referred to as dandelion, is a herbaceous perennial species within the family Asteraceae. It is widely distributed across Europe, Asia, and North America, and is recognized as a prevalent weed in diverse habitats including cultivated fields, gardens, pastures, and disturbed or waste areas (Di and Zucchetti, 2021). Dandelion (*T. officinale*) is a rich source of diverse phytochemicals exhibiting a range of biologically active properties. Notable constituents include sesquiterpene lactones, which possess anti-inflammatory and antimicrobial activities; triterpenes and phytosterols, associated with antiatherosclerotic effects; and phenolic acids, known for their antioxidant and immunostimulatory properties (Duraisami *et al*., 2021). Additionally, the plant contains coumarins, which have been reported to exhibit antitumor, anti-inflammatory, antimicrobial, and anticoagulant activities, as well as flavonoids that contribute to its overall antioxidant capacity (Schütz *et al.,* 2006; González-Castejón *et al.,* 2012; Sivakumar *et al*., 2022; Xu *et al.,* 2019). The roots of *T. officinale* are particularly notable for their high content of inulin, a storage carbohydrate with demonstrated prebiotic effects (González-Castejón *et al.,* 2012). Due to its diverse nutritional profile, which includes essential vitamins, minerals, and fatty acids, the consumption of *T. officinale* may exert beneficial effects on human health (Lis and Olas, 2019).

Dandelion is a rich source of vitamins A, E and C. One gram of fresh dandelion leaf contains 121.86 µg of vitamin C (Tuwar and Kulkarni, 2020), 0.436 µg of vitamin E and 119.5 µg of carotenoids (Almedia *et al.,* 2022). Due to its substantial vitamin contents, it has been studied in different parts of the world such as Brazil (de Almeida *et al.,* 2022), Russia (Frolova *et al.,* 2024), China (Wu *et al.,* 2025), Turkey (Türkmen *et al*., 2024), and India (Laila *et al*., 2025). Leaves and other parts of the plant are used as functional foods and therapeutics due to its high vitamin and phytochemical constituents (Laila *et al.,* 2025).

Flavonoids compounds present in dandelion are complex and a little is known about their structure to antioxidant activities relationship. Using LC-MS analysis, it was observed that, dandelion contains hesperetin-52 O-β-rhamnoglucoside, hesperetin-7-glucuronide, kaempferol-3-glucoside, baicalein, and hyperseroside. Hesperetin-

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5' O-β-rhamnoglucoside showed remarkable antioxidant activities (Wang *et al.,* 2023). Dandelion plant is being used to study *in vitro* and *in vivo* antioxidant activities due to its flavonoid content. An updated information on structure and function of the all the flavonoids present in dandelion has been reviewed thoroughly (Zhuang *et al.,* 2024).

Along with vitamins and flavonoids, dandelion is also a rich source of minerals. It was observed that the plant is rich in minerals like calcium, iron, magnesium, potassium and zinc and detectable amount of manganese, selenium, copper, molybdanum, and sodium. Trace amount of chromium, aluminium and nickle were also found (Almeida *et al.,* 2022). One of the important growth parameters in plants is pigment content which is total chlorophyll and carotenoids. Apart from these major pigments, other pigments like lutein epoxide, chrysanthemaxanthin, flavoxanthin, neoxanthin are present in flowers (Yan *et al.,*2024). The aim of this study is to find out micronutrients, flavonoids and vitamin contents of *T. officinale* due to its medicinal properties and importance in traditional and complementary medicines. This research study will help practitioners and researchers working on plant-based medicines.

2. Materials and Methods

2.1 Collection of *Taraxacum officinale* L.

The *Taraxacum officinale* L., was authenticated by Professor Orzimat Turginov, National Herbarium of Uzbekistan (TASH), Tashkent, Uzbekistan. A Voucher Specimen No. 20042025 was placed in the Herbarium unit. *T. officinale* which were at fresh vegetative stages have been collected from territory of the Chatkal State Biosphere Reserve. Chatkal State Biosphere Reserve is located on the western and northern slopes of Chatkal Range of the Western Tien Shan (Figure 1). The reserve is situated at Tashkent Region in Uzbekistan at an altitude ranging from 1500 to 3900 meters above sea level.

Figure 1: Fresh *Taraxacum officinale*.

2.2 Photosynthetic pigments measurement

The total chlorophyll, chlorophyll a, chlorophyll b, and carotenoid contents of leaves of *T. officinal* were determined by Hiscox and Israelstam (1979). A fresh leaf (50 mg) of the *T. officinale* sample was cut and dissolved in 5 ml of dimethyl sulfoxide in test tubes. The test tubes were incubated at 37°C for 4 h. Then, absorbance of the extract was determined at 470 nm, 645 nm, and 663 nm using a spectrophotometer (SP-UV1100).

2.3 Determination of flavonoids and vitamins

T. officinale plant samples were dried in the room temperature. The analysis was performed using HPLC with gradient elution mode and diode array detector (DAD). Acetonitrile and buffer solution were used as mobile phase. Spectral data were analysed in the spectral range from 200 to 400 nm. Chromatography conditions: Chromatograph - Agilent Technologies 1260. Mobile phase (gradient mode) - acetonitrile - buffer solution pH = 2.92 (4%:96%) 0-6 min., (10%: 90%) 6-9 min., (20%: 80%) 9-15, (4%:96%) 15-20 min. Injection volume - 10 µl. Mobile phase flow rate - 0.75 ml/min. Column - Eclipse XDB - C18. 5.0 µm, 4.6 × 250 mm. Detector - diode-matrix detector, wavelengths 254, 320 nm. Water-soluble vitamins were also analyzed using HPLC with gradient elution and a diode array detector (DAD), employing acetonitrile and a buffer solution as the mobile phase. Spectral data for these vitamins were collected in the 200 to 400 nm range (Shelemetyeva, 2009).

2.4 Determination of plant nutrients

For six hours, plant samples were disintegrated using hydrogen peroxide and nitric acid in a special microwave oven until they were reduced to their atomic elements for examination. Accurate volumetric measurements were made for the samples before being subjected to the nitric acid solution. The analysis was carried out using an optical emission spectrometer with an inductively coupled argon plasma (2100 DV Santa Clara, CA, USA) (Jabborova *et al.,* 2021).

2.5 Statically analysis

ANOVA was used to examine experimental data with the IBM SPSS Statistics 20.

3. Results

3.1 Photosynthetic pigments of *T. officinale*

The morphology of *T. officinale* was extremely heterogeneous, particularly for its medicinal as well as nutritional significance. Chlorophyll contents were well balanced in the plant, with chlorophyll a found to be at 1.83 mg/g and chlorophyll b at 1.96 mg/g, to provide total content of chlorophyll content upto 3.79 mg/g. The carotenoid content was found to be 3.85 mg/g also reflected extensive antioxidant capacity, making it a potential candidate for bioactive compounds (Figure 2).

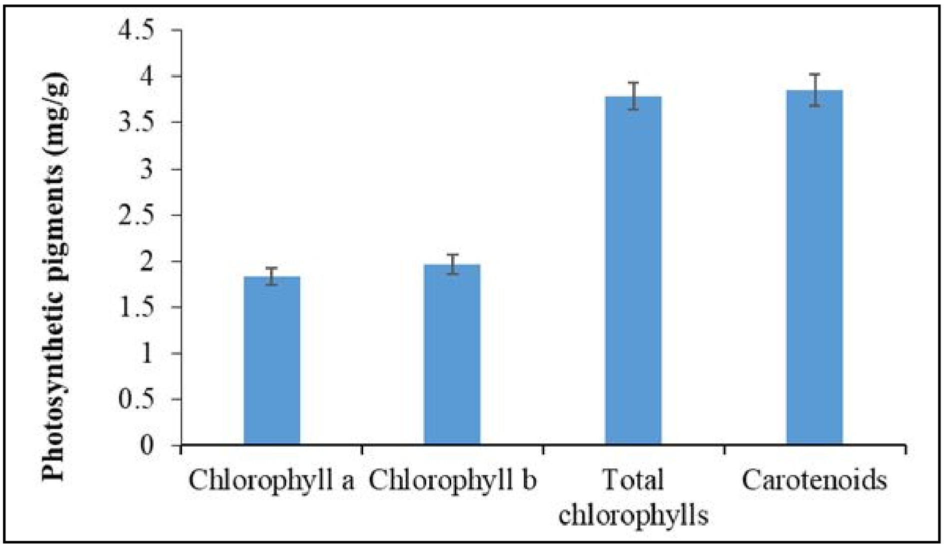

Figure 2: Photosynthetic pigments of *T. officinale*.

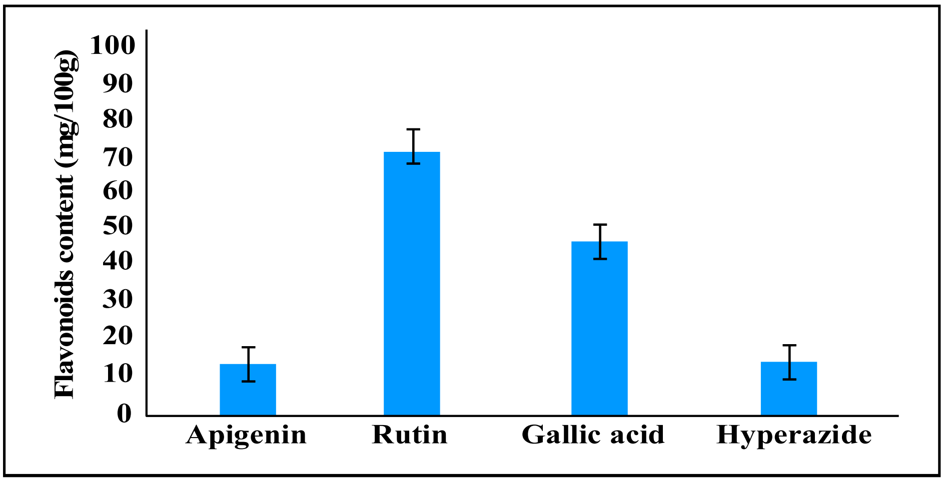

Figure 3: Flavonoids content of *T. officinale*.

3.2 Flavonoids and vitamins content of *T. officinale*

Flavonoid composition identified the presence of different vital bioactive compounds including apigenin at 16.041 mg/100 g, rutin at 83.432 mg/100 g, gallic acid at 50.832 mg/100 g, and hyperoside at 18.574 mg/100 g (Figure 3). These compounds have been previously reported to be conducive to human health through positive effects on anti-inflammatory and antioxidant processes.

The nutritional importance of the vitamin content in *T. officinale* also revealed its highest importance being that of vitamin B2 at 34.962 mg/100 g, followed by that of vitamin C at 28.985 mg/100 g, vitamin B12 at 19.596 mg/100 g and vitamin B9 at 18.248 mg/100 g reflecting on its promising involvement in metabolic status as well as in immune processes (Figure 4).

3.3 Macro-micronutrient contents of *T. officinale*

Macronutrient analysis revealed the occurrence of very high amounts of potassium, *i.e.*, 109.282 mg/g, a very critical element for physiological and cell functions. Other very crucial macronutrients were calcium at 20.77 mg/g, phosphorus at 12.965 mg/g, magnesium a 2.56 mg/g, sodium as 9.138 mg/g and sulphur as 1.955 mg/g (Figure 5) all which have very critical functions in very critical biological processes such as bone fixation, enzyme activity, and electrolyte balance.

Micronutrient analysis revealed notable levels of iron at 6.361 mg/g, manganese at 0.771 mg/g, and zinc at 0.474 mg/g as well as trace elements like boron at 0.393 mg/g, silicon at 2.425 mg/g and aluminium at 6.088 mg/g. All the micronutrients play crucial roles in structural processes and the regulation of metabolism (Figure 6).

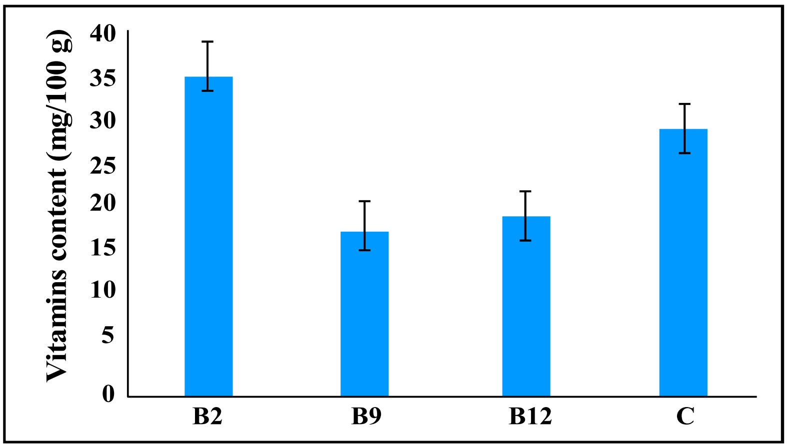

Figure 4: Vitamins content of *T. officinale*.

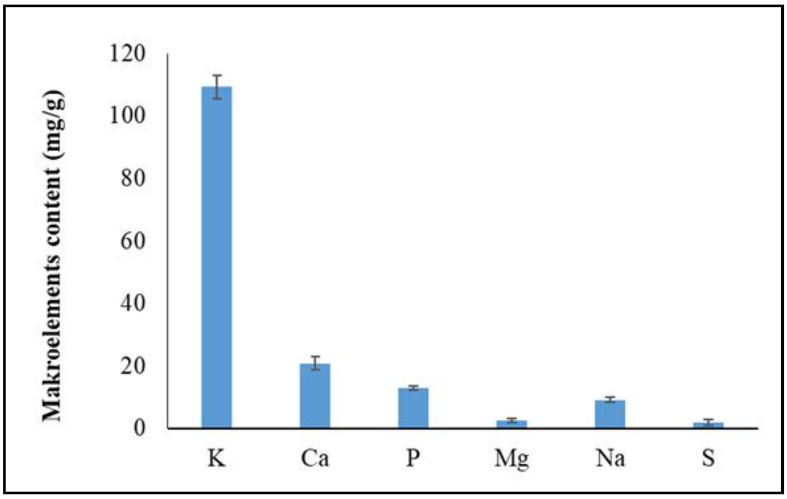

Figure 5: Macro-elements content of *T. officinale*.

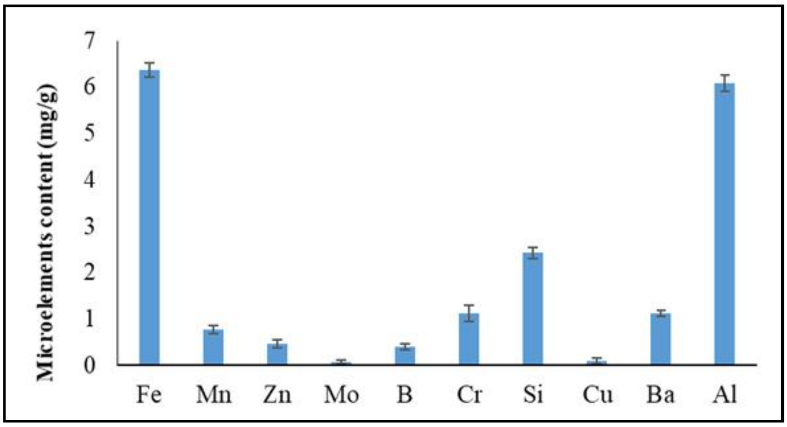

Figure 6: Microelements content of *T. officinale*.

Ultra-trace elements such as lithium at 0.075 mg/g, vanadium at 0.078 mg/g, nickel at 0.129 mg/g, and strontium at 0.743 mg/g were present but their specific physiological function needs to be determined through further studies (Figure 7).

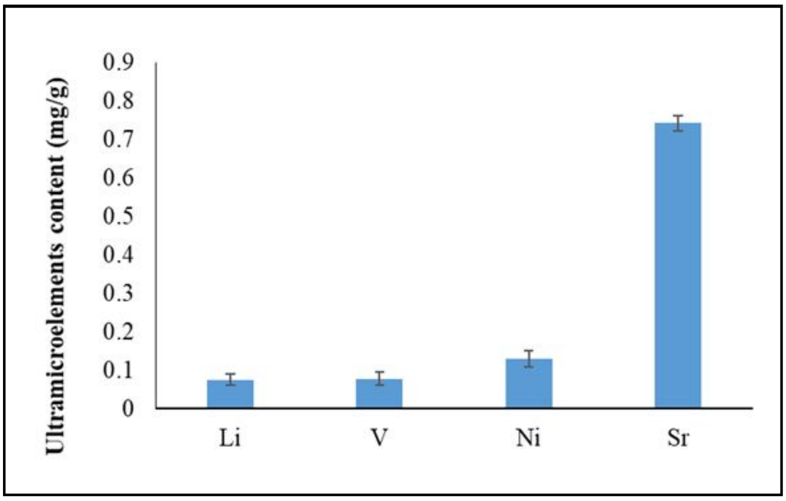

Figure 7: Ultramicroelements content of *T. officinale*.

4. Discussion

Our finding shows significant amount of photosynthetic pigments, flavonoids, micronutrients, macronutrients and ultramicronutrients in *T. officinale* (Figures 1 to 7). The maximum content of flavonoids found was rutin (83.432 mg/100 g) and minimum was recorded as apigenin (16.041 mg/100 g). This plant is a rich source of flavonoids, studied by different scientist (Lis and Olas, 2019; Xue *et al.,* 2017; Lis *et al.,* 2020). Phytochemical investigations have identified the presence of minor flavonoids in the roots of *T. officinale*, predominantly luteolin and apigenin (Kenny *et al.,* 2014; Huber *et al.,* 2015).

The present study places in focus the high phytochemical and nutrient density of *T. officinale* (dandelion) and its potential as a medicinal crop and functional food. The study revealed the photosynthetic pigment concentrations of total chlorophyll at 3.79 mg/g and carotenoids at 3.85 mg/g which highlights the richness in antioxidant capacity of the plant. Chlorophyll a and chlorophyll b were at 1.83 mg/g and 1.96 mg/g respectively, indicating an optimal pigment ratio, which is most favoured for photosynthetic efficiency. Carotenoids that are exhibiting anti-inflammatory as well as the activity of decreasing oxidative stress, also indicate the medicinal value of the plant.

Based on flavonoid content, rutin was the most prevalent flavonoid with 83.432 mg/100 g, followed by gallic acid with 50.832 mg/100 g, hyperoside with 18.574 mg/100 g, and apigenin with 16.041 mg/100 g. Rutin is widely known for its vascular protective and anti-inflammatory activities, whereas apigenin has anticancer property, thus *T. officinale* is a potential source of bioactive compounds. The flavonoid antioxidant activity of flavonoids like hyperoside and gallic acid is the cause of the medicinal significance of the plant (Sri Bhuvaneswari *et al*., 2023). Lis and Olas (2019) emphasized the relevance of dandelion flavonoids in the modulation of oxidative stress and potentiation of health effects. Recent research on dandelion flavonoids is centred on their structure-activity relationships and potential in the treatment of a number of metabolic disorders (Zhuang *et al.,* 2024).

The vitamin content of *T. officinale* also emphasizes its nutritional content vitamin B2 in the form of 34.962 mg/100 g, vitamin C at 28.985 mg/100 g, vitamin B12 at 19.596 mg/100 g, and vitamin B9 as 18.248 mg/100 g. Vitamin B2 helps in energy metabolism and vitamin C plays a vital role in the immune system and responding to oxidative stress. Studies in Brazil and Russia also marked dandelion as a rich source of essential vitamins and therefore an excellent food item to use in preventing deficiency diseases (Almeida *et al.,* 2022; Frolova *et al.,* 2024).

Macronutrient analysis showed potassium as the most prevalent element with 109.282 mg/g, followed by calcium at 20.77 mg/g, phosphorus at 12.965 mg/g, and magnesium at 2.56 mg/g. Potassium is responsible for maintaining cellular functions and osmotic balance, while calcium and phosphorus are responsible for bone strength and metabolism. Availability of these macronutrients positions *T. officinale* at the forefront as a nutrient-dense plant that can be incorporated into nutrition interventions (Türkmen *et al.,* 2024). Micronutrient analysis measured critical iron concentrations at 6.361 mg/g, manganese at 0.771 mg/g, and zinc at 0.474 mg/g, all being critical for enzymatic function and immunomodulation. Boron and silicon were present in trace amounts and ultra-trace elements such as lithium and vanadium, further expanding the mineral profile of the plant. Such research has noted massive coverage by such nutrients in leaves of dandelion, and thus they play an important role in plant-based therapeutic modalities (Huber *et al.,* 2015; Kenny *et al.,* 2014). *T. officinale* shows a high level of adaptability and bioactivity contained within its diverse phytochemical and mineral profile. It is used from traditional medicine to modern nutraceuticals, curing many diseases of health. Future research is required to explore genetic variation in phytochemical content and synergic activities of flavonoids and vitamins. Furthermore, application of the plant profile towards sustainable agriculture and dietary intervention by plants is of significant potential in the future.

5. Conclusion

The findings of this study demonstrate the great nutritional and therapeutic benefits of *T. officinale*. The plant's high concentration of flavonoids, vitamins, vital minerals, and photosynthetic pigments made it a multipurpose bioactive ingredient. Its pigment richness suggests a high level of antioxidant activity, and the separated flavonoids have medicinal and anti-inflammatory properties. The macronutrients and micronutrients support its importance in cellular metabolism, bone, and enzymatic processes, while the vitamin content supports its role in metabolic and immunological processes. The plant's use as a medication and nutritional supplement is improved by trace and ultra-trace components. To optimise its phytochemical output and synergistic qualities of bioactive substances, more study may be conducted. In addition, including *T. officinale* into nutraceutical research and sustainable agriculture creates new opportunities to further its use in the food and medical sectors. It can be used as a useful tool for both conventional and alternative treatment is further supported by this study.

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Conflict of interest

The authors declare no conflicts of interest relevant to this article.

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