JOURNAL OF AGRICULTURE

RESEARCH ARTICLE ISSN: 2636-8757

Phenolic compounds of Rumex acetosella L. collected from two different regions of Iğdır province (Türkiye)

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Abstract: This investigation examines the phenolic profile of *Rumex acetosella* L. harvested from two disparate locales within Iğdır Province, Türkiye, aimed at evaluating the impact of different locations on phenolic compounds. Employing High-Performance Liquid Chromatography (HPLC), a total of 19 phenolic constituents, including chlorogenic acid, caffeic acid, rutin, and naringin, were both identified and quantified. Crucial regional variations were identified, with Hoşhaber presenting higher levels of chlorogenic acid, rutin, and naringin in comparison to Karakuyu. However, caffeic acid was found to be more prevalent in the Karakuyu region. Certain compounds, notably vanillin and p-coumaric acid, were exclusively identified in Hoşhaber. These results substantiate the premise that environmental determinants, encompassing soil composition and climatic conditions, significantly influence phenolic biosynthesis.

Keywords: Medicinal and aromatic plants, secondary metabolites, phenolics, sorrel

INTRODUCTION

Sorrel (Rumex acetosella L.) is a perennial herb belonging to the family Polygonaceae and is widely distributed worldwide (Bello et al., 2019), being considered as of the crucial medicinal and aromatic plants. The species has a wide array of biological activities including antioxidant (Baig et al., 2011; Irtegün et al., 2024), antimicrobial (Irtegün et al., 2024; Akay et al., 2024) and anti-cancer (Jothika et al., 2024; Irtegün et al., 2024), as evidenced from the Figure 1.According to a very recent report by Irtegün et al. (2024), a series of phyto-chemicals, viz. shikimic acid, cafeic acid, p-coumaric acid, and trans-ferulic acid etc. have been screened but luteolin-7-Oglucoside, polydatine and shikimic acid were the most pronounced compounds. As reported in a quite number of documents (Chinou, 2008; Hostettmann and Wolfender, 1997), the activities of extracts are crucially dependent on the composition and content of the metabolites.The chemical composition is not constant but being responsive to minute stimuli from environmental variations (Jan et al., 2021; Akula et al., 2011; Khare et al., 2020; de Almeida et al., 2024). Such reasons make the plants to be screened for their compositions to reveal the rich-chemotypes or eco-types of the species (de Almeida et al., 2024). In this context, it was hypothesized that different collection locations might be influential on the chemical composition and content of the

Received: 06-12-2024 | Accepted: 17-12-2024

species. In this study; R. acetosella species were collected from two different regions of Iğdır province (Türkiye) and then were screened for their phenolic compounds.

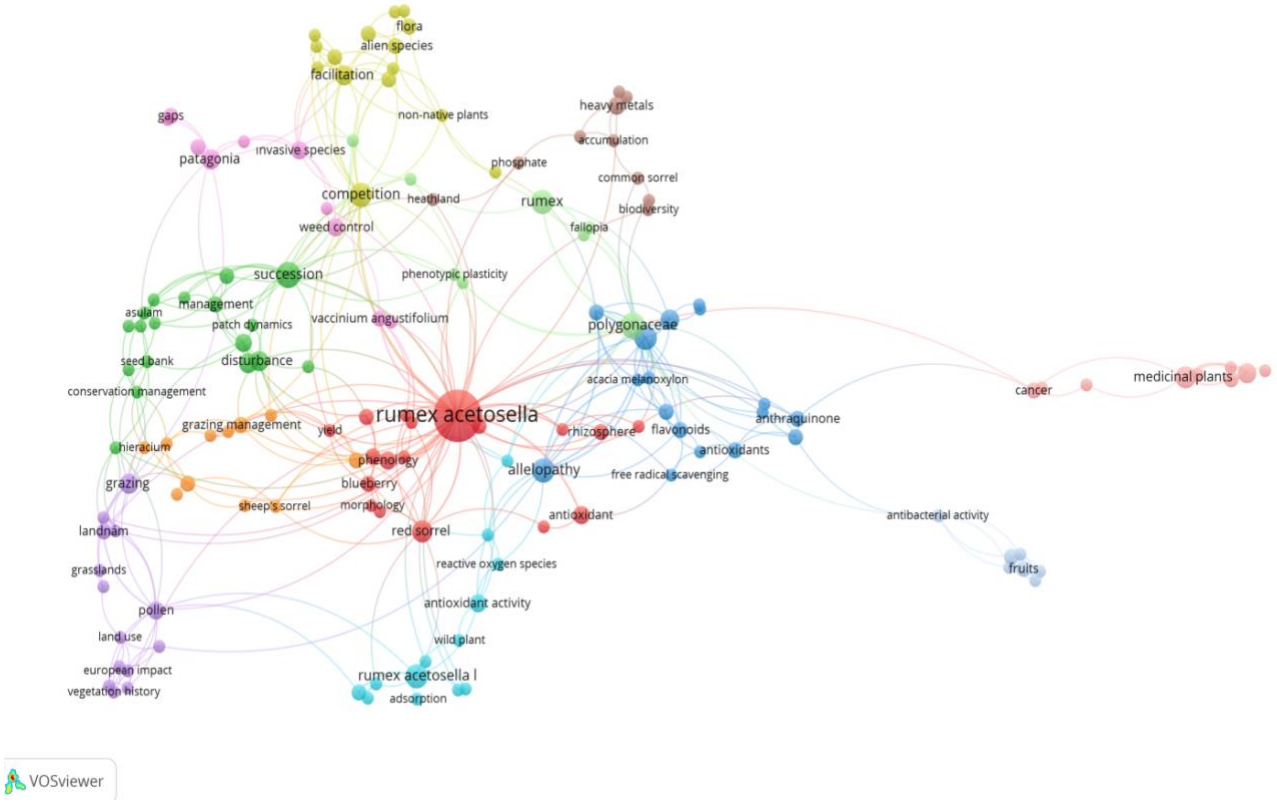

Figure 1. *The keywords retrieved from the documents of R. acetosella, according to SCOPUS database*

MATERIALS and METHODS

Plant Collection

The plants were collected from two different regions, namely, Karakuyu (39.863761, 44.033621) and Hoşhaber (39°54'17.7"N 43°58'03.0") (Iğdır, Türkiye). The plants were taxonomically identified by a botanist and specimens were stored with a voucher number (MK-TBMYO-001 and 002, respectively). The plants were dried at room conditions at Research Application Laboratory and Research Centre (ALUM). Then, the dried samples were powdered using a grinder (Emir Makine).

Extraction And Individual Phenolic Analysis By High-Performance Liquid Chromatography (HPLC)

The extraction was performed according to Başar and Karadağ (2024) with some modifications. Briefly, the powdered plant samples (20 g) were subjected to extraction using 250 mLmethyl alcohol and 250 mL chloroform for 72 h.Following the extraction period, the solvents were evaporated using a rotary evaporator (Heidolph). The extracts were then stored at +4 ^{0}C. The compounds were quantified using HPLC (Agilent 1260; Agilent, Santa Clara, CA, USA).The running conditions of HPLC were as the report of Kumlay et al. (2022). The experimental flow of the study is presented in Figure 1.

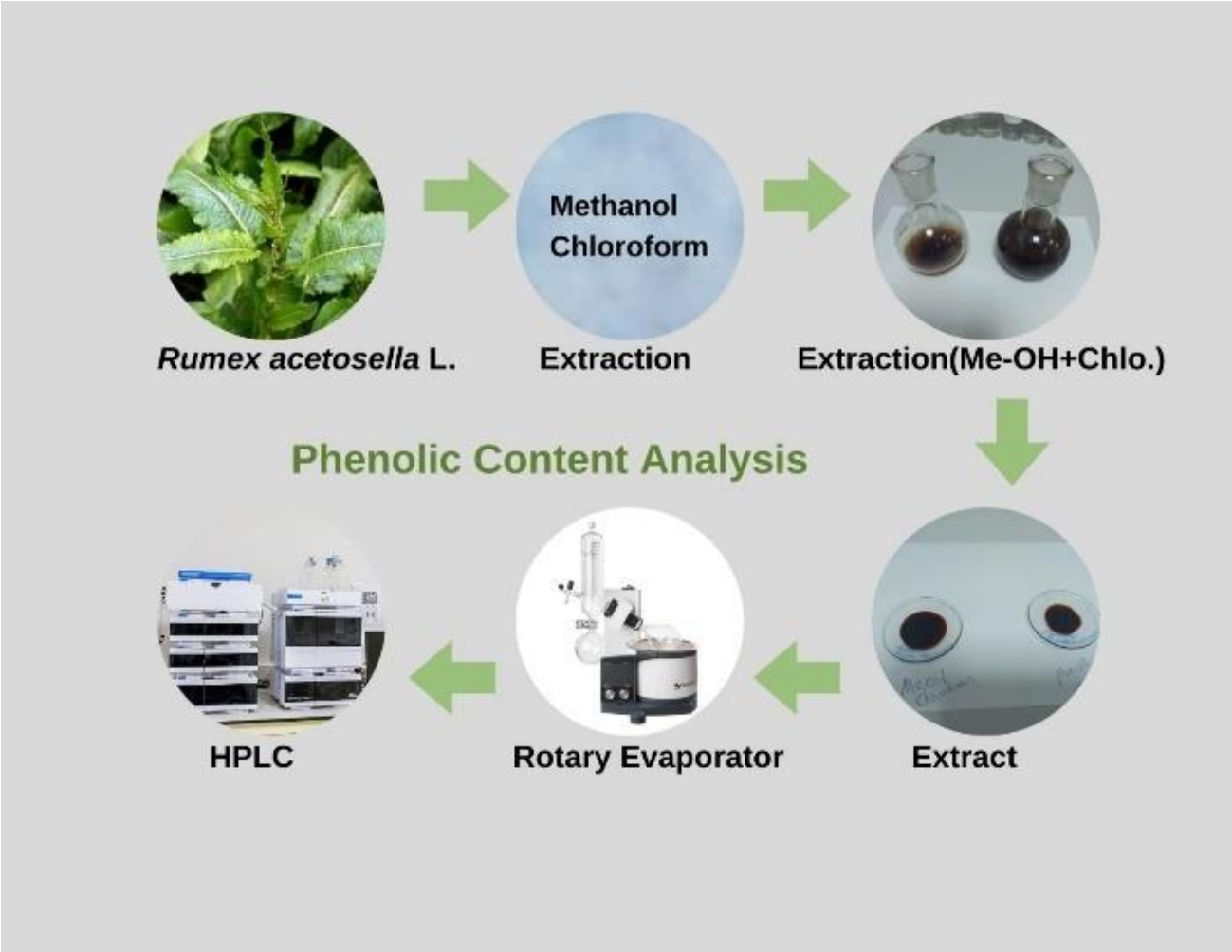

Figure 1. *Experimental flow of the study*

RESULTS and DISCUSSION

In the present study, 19 phenolic compounds were screened and quantified in the plants (Fig. 2-3, Table 1). These include important bioactive plants such as chlorogenic acid, caffeic acid, vanillin, p-coumaric acid, rutin, ferulic acid, salicylic acid, resveratrol, naringin, quercetin and apigenin. The results revealed the significant variations in the concentrations of individual compounds between the two regions (Table 1). Of the compounds analysed, chlorogenic acid was detected in both regions, with markedly elevated concentrations recorded in the Hoşhaber region (17,335.962 ng/µL) in comparison to the Karakuyu region (4,187.625 ng/µL). Chlorogenic acid has been extensively investigated in a quite number of reports. In those reports, the plant has been found to possess a number of beneficial properties, including its ability to enhance cognitive function and neuroprotective effects, act as a food additive, and function as an antioxidant (Sato et al., 2011; Lu et al., 2020; Singh et al., 2023; Tajik et al., 2017; Heitman and Ingram, 2017).In addition to the benefits for human being health and well-being of the chlorogenic acid, concerning with the plant health under changing environmental conditions; a wide spectrum of the physiological functions have been reported (Sheen, 1973; Xiao et al., 2024; Lallemand et al., 2012).

In a similar manner, the content of rutin was significantly greater in the Hoşhaber region (10,656.994 ng/µL) relative to the Karakuyu region (447.313 ng/µL). Naringin also exhibited a notable disparity, with concentrations of 111,392.878 ng/µL in Hoşhaber versus 29,219.358 ng/µL in Karakuyu.As evidenced from the previous papers (Yang et al., 2008; Chua, 2013), as in the case of Chlorogenic acid; rutin exhibits crucial activities, viz., antioxidant and pharmacological activities. Furthermore, rutin exerted a significant protective role in combating with the salinity stress by regulation of ionic status of the leaf mesophyll (Ismail et al., 2015). The reasons for rutin being the major compound in the phenolic pools analysed can be explained by the salinity stressed soil regions of Igdir. The soil salinity status of Igdir province has already reported (Karaoğlu and Yalçın, 2018; Temel and Şimşek, 2011).

Table 1. *Individual phenolic compounds quantified in R. acetosella collectedfrom Karakuyu and Hoşhaber regions*

Retention Time [min]	Compounds	Karakuyu Regions [ng/ul]	Hoşhaber Regions [ng/ul]
6.330	Chlorogenic acid	4.187.625	17.335.962
6.560	Catechine hydrate	ND	ND
9.435	Caffeic acid	4,71E+04	74.245
13.653	4-Hydroxy benzoic acid	ND	ND
16.382	Vanillin	ND	114.239
16.920	p-Coumaric acid	136.275	959.078
19.852	Rutin	447.313	10.656.994
20.361	t-Ferulic acid	ND	483.939
23.378	Hydroxy sinamic acid	ND	2.52E-01
27.613	Naringin	29.219.358	111.392.878
28.779	o- Coumaric acid	6.58488e- 2	7.86E-01
30.312	Rosmarinic acid	4.40947e -1	ND
31.587	Salicylic acid	2,14E+04	474.457
32.433	Resveratrol	7.94691e- 1	561.897
34.793	Quercetin	594.314	1.245.246
35.526	t -Cinamic acid	2.148.085	710.688
36.339	Naringenin	9.56609e -1	754.098
38.986	Chrysin	142.413	1.769.479
40.770	Flavones	ND	ND

**ND: Not detected*

Of the compounds, caffeic acid and quercetin, were quantified in both regions, exhibiting significant variability. For instance, the concentration of caffeic acid was found to be markedly higher in Karakuyu (47,100 ng/µL) in comparison to Hoşhaber (74.245 ng/µL) whereas the quercetin levels

were observed to be more pronounced in Hoşhaber (1,245.246 ng/µL) relative to those in Karakuyu (594.314 ng/µL).As in the case of many phyto-chemicals, caffeic acid and quercetin also exhibit dual crucial functions for human (Jiang et al., 2005; Tolba et al., 2013; Wang et al., 2016; Alizadeh and Ebrahimzadeh, 2022)and plant health under salt stress (Xu et al., 2020; Parvin et al., 2019; Mehmood et al., 2021; Ramzan et al., 2024; Klein et al., 2015).

It is noteworthy that a variety of compounds, including vanillin, p-coumaric acid, and ferulic acid, were identified solely in the Hoşhaber region, whereas other compounds, including hydroxybenzoic acid and hydroxy sinamic acid, were not identified in either of the examined regions.

Such critical variability in concentration of the compounds might clearly confirm the hypothesis driven in this study. In a very recent study (Irtegün et al., 2024), luteolin-7-O-glucoside, polydatine and shikimic acid were the most pronounced compounds.Kucekova et al. (2011) reported the compounds, *viz.* resveratrol, vanillic acid, sinapic acid and catechin. Santos et al. (2017) also reported trans-resveratrol as compound. As well reported in a quite number of reports (Cetinkaya et al., 2017İ; Cetinkaya and Kulak, 2016), environmental factors including soil composition, climate, slope, altitude are of the crucial predictors on the biosynthesis of the metabolites.

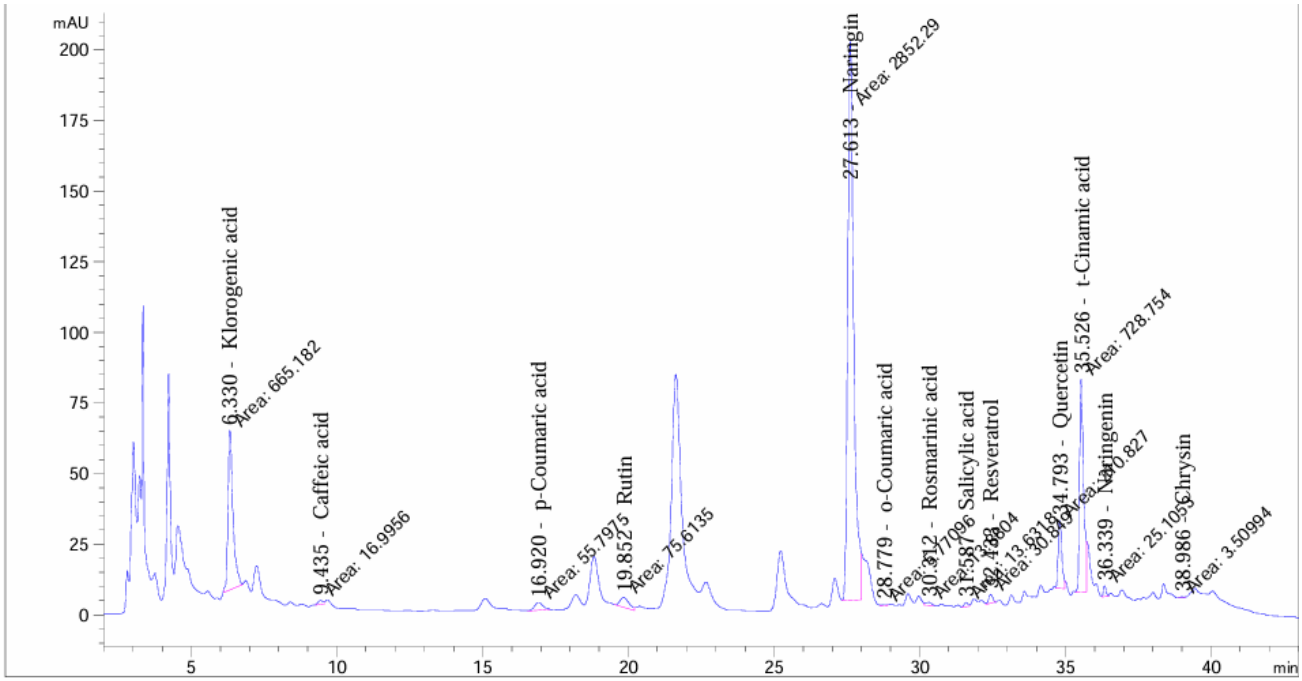

Fig.2. *HPLC chromatogram of R. acetosella collectedfrom Karakuyu regions*

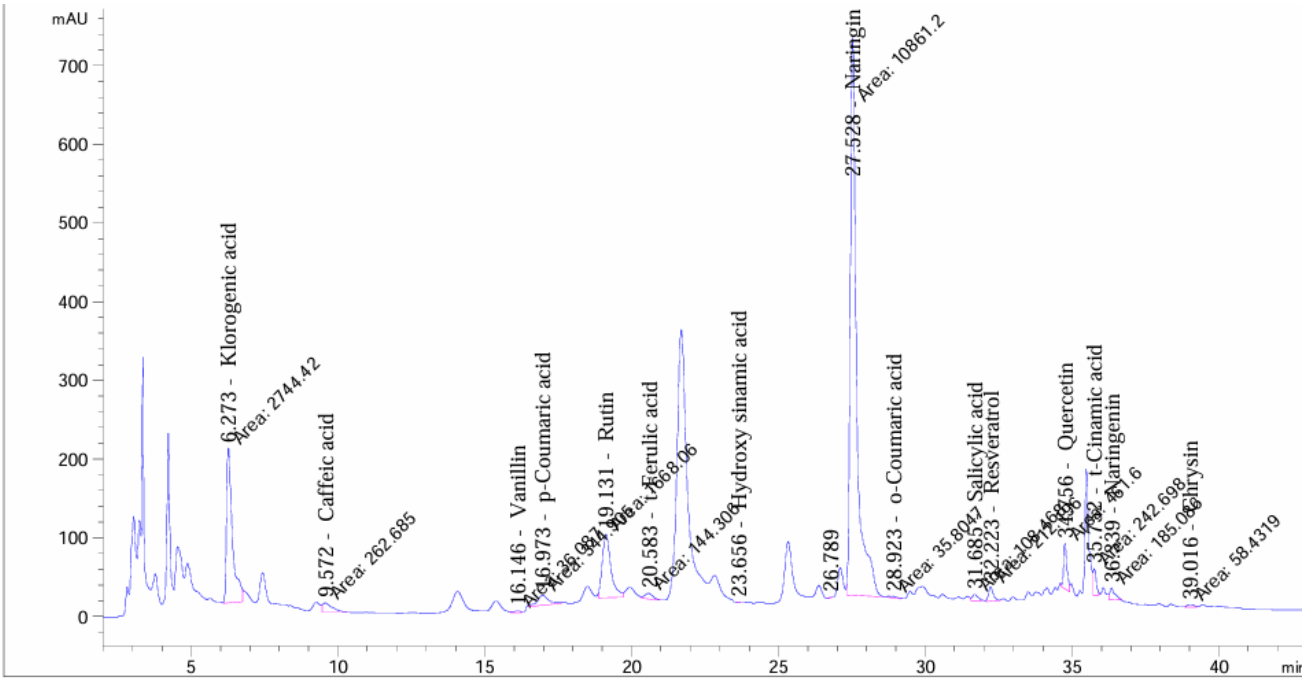

***Fig.3**. HPLC chromatogram of R. acetosella collected from Hoşhaber regions*

CONCLUSION

The present study was designed to compare the phenolic compounds of R. acetosella collected from two different regions. Of the regions considered, the Hoşhaber region was found to be richer in several bioactive compounds, such as chlorogenic acid, rutin, and naringin, while Karakuyu exhibited higher levels of caffeic acid.The present results clearly revealed the environmental effects on biosynthesis of the phenolics considered for the analysis. The identification of region-specific phenolic profiles provides valuable insights into the chemotypic diversity of R. acetosella and offers potential strategies for optimizing its medicinal properties through location-specific cultivation.

ACKNOWLEDGEMENTS

We thank the anonymous referees for their contributions to improve the manuscript.

AUTHOR CONTRIBUTIONS

The authors contributed equally to this study.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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