JBP
Journal of Biochemicals and Phytomedicine
eISSN: 2958-8561

Fourier Transform Infrared Spectroscopic Analysis of *Kelussia odoratissima Mozaff.* (Keluss) and *Portulaca oleracea*: Two Valuable Herbs

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ARTICLE INFO

Article Type:
Research

Article History:
Recived: 01 Nov 2022
Revised: 03 Jan 2023
Accepted: 19 Jan 2023
Available online: 1 March 2023

Keywords:
Fourier transform infrared spectroscopy
Medicinal plants
Keluss
Purslanes
Spectroscopy

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ABSTRACT

Introduction: *Kelussia odoratissima* Mozaff. (Keluss) and Purslanes with the scientific name *Portulaca oleracea* have many uses in the food and pharmaceutical industries due to their antioxidant properties. The purpose of this study was to identify the functional groups of Keluss and purslanes native to Ilam by fourier-transform infrared spectroscopy (FTIR) method, so that by knowing the main and effective compounds of the plants, we can more easily move towards the identification and production of bio-molecules and effective herbal medicines.

Methods: *Kelussia odoratissima* Mozaff. (Keluss) and Purslanes with the scientific name *Portulaca oleracea* have many uses in the food and pharmaceutical industries due to their antioxidant properties. The purpose of this study was to identify the functional groups of Keluss and purslanes native to Ilam by fourier-transform infrared spectroscopy (FTIR) method, so that by knowing the main and effective compounds of the plants, we can more easily move towards the identification and production of bio-molecules and effective herbal medicines.

Results: Based on the results of spectrometry, it was found that *K. odoratissima* has 9 spectra including N-H, C-H, C-H, C=O, C=N, C-H, C-N, S=O, and C-Br. Furthermore, it was observed that *P. oleracea* has 13 spectra including O-H, O-H, N-H, C=O, C=N, C=C, C-H, S=O, C-H, C-H, C-O, C=C, and C-H groups.

Conclusion: The results of the present investigation revealed that *K. odoratissima* and *P. oleracea* had a variety of the FTIR spectrum profile including different functional groups which are responsible for their biological properties.

Please cite this paper as:
Shahsavari S. Fourier transform infrared spectroscopic analysis of *Kelussia odoratissima* Mozaff. (Keluss) and *Portulaca oleracea*: Two valuable herbs. Journal of Biochemicals and Phytomedicine. 2023; 2(1): 11-15. doi: 10.34172/jbp.2023.4.

Intorduction

Kelussia odoratissima Mozaff. (Keluss) which is also known as Bakhtiari celery, is a wild plant from the Apiaceae family that grows in the spring and is found in a yellowish green color. *K. odoratissima* is a very fragrant medicinal plant (Ahmadi et al., 2019). Various parts of this plant are used to relieve stomach pain, treat arthritis

and rheumatism, and purify the blood. Furthermore, Keluss is used in the treatment of high blood fat, high blood pressure, various cardiovascular disorders and back pain (Ramezani et al., 2022). The essential oil in the seeds and roots of the plant attracts insects and facilitates pollination, repels some animals and plant pests, and protects against damage caused by increased heat (Shafaroodi et al., 2023). Keluss leaves, stalks, and flowers can be used to prepare products such as pickled keluss or to cook some foods such as soup or together with yogurt, and can also be used as a dry powder to flavor ayran. Root decoction of *K. odoratissima* is used to treat flu, colds, severe coughs and shortness of breath (Ahmadi et al., 2019). Other parts of the plant can be used to relieve stomach pain, treat joint inflammation, rheumatism, and blood purification.

Purslanes with the scientific name *Portulaca oleracea* is an herb that is mostly cultivated in the Mediterranean region. This plant is widely used in Europe, Asia, Middle East, and Africa. It is a succulent annual plant with a sour and sugary taste that makes it a favorite addition to food. The whole plant including leaves, stems, flowers and seeds are edible and have been used for thousands of years in different ways. Purslanes vegetable contains a very high amount of omega-3 fatty acid and a significant amount of fiber, vitamins B, C and A, iron, magnesium, manganese, potassium, calcium, and copper. In addition to betalain seeds; A strong antioxidant and carotenoid combination; Also, this veritable treasure trove of nutrients has been supplemented with other beneficial organic compounds (Jalali et al., 2022). Purslane herb is used to treat dysentery, gastrointestinal bleeding, and even hemorrhoids in traditional Chinese medicine. Purslane also improves the function of the digestive system. Strengthening vision and preventing cataracts are other properties of purslane. Purslane contains several types of minerals, which heals bones and prevents osteoporosis (Duan et al., 2022). Purslane relieves bile, blood heat, hot headache, liver and stomach and quenches thirst. Purslane is diuretic and anti-bladder stone agent (Xu et al., 2022). So far, spectrometry has not been done for the functional groups of keluss and purslanes of Ilam, so the purpose of this study was to identify the functional groups of Keluss and purslanes native to Ilam by Fourier-transform infrared spectroscopy (FTIR) method.

Materials and Methods

Plant Collection

In this study, *K. odoratissima* and *P. oleracea* (Figure 1 and 2) were collected from Ilam county, Ilam province, west of Iran. Identification and confirmation of plant species was done at the Biotechnology and Medicinal Plants Research Center, Ilam University of Medical Sciences, Ilam, Iran. The characteristics and collection area of *K. odoratissima* and *P. oleracea* are specified in Table-1.

Plant Material Preparation

The seeds of *K. odoratissima* and *P. oleracea* were used in the present study. After identification of the species of these plants, their seeds were dried. Then, the dried seeds of the plant were ground by a mixer.

Figure 1. *Kelussia odoratissima* Mozaff. (Keluss)

Figure 2. *Portulaca oleracea*

Table 1. The botanical characteristics and collection area of *Kelussia odoratissima* Mozaff. (Keluss) and *Portulaca oleracea*

Local name	Scientific name	Herbal family	Location
Karafse kouhi	*Kelussia odoratissima* Mozaff. (Keluss)	Apiaceae	Ilam
Khorfe	*Portulaca oleracea*	Portulacaceae	Ilam

FTIR Analysis

Dried seed powder of *K. odoratissima* and *P. oleracea* was used for FTIR analysis. FTIR analysis was used to identify the functional groups of chemical compounds and qualitatively identify the type of bonds in the mentioned plants. Since sample used in this research was in powder form, the method of preparing KBR (potassium bromide) tablets was used. To prepare the sample using the KBR (potassium bromide) tablet method, the solid sample was completely powdered and mixed with powdered potassium bromide, then under the pressure of 10 tons of the apparatus, this mixture was made into a small tablet. The reason for using potassium bromide was that it does not produce any peaks in the region of 650-1 cm to 400-4000 cm. Finally, the sample was placed in front of the radiation and the spectrum was obtained by Fourier transformation. Therefore, only the peaks of plant samples were known in spectroscopy (Zhu et al., 2010). Finally, the functional groups were identified and reported based on the obtained different spectra.

Results

Based on the results obtained from the spectroscopy of *K. odoratissima*, it was found that this plant had 9 peaks for the functional groups. The details of the functional groups obtained from this plant have shown in Table-2 and in Figure-3. It was found that *K. odoratissima* has 9 spectra including N-H, C-H, C-H, C=O, C=N, C-H, C-N, S=O, and C-Br.

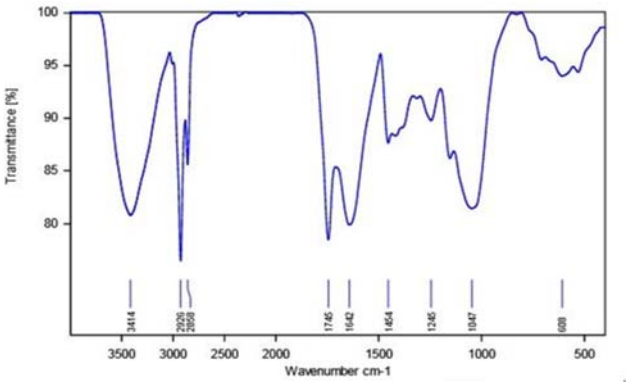

Figure-3. FTIR chromatogram of the seeds of *Kelussia odoratissima* Mozaff. (Keluss).

Nine spectra including N-H, C-H, C-H, C=O, C=N, C-H, C-N, S=O, and C-Br has been shown.

The results of spectroscopy of *P. oleracea* have been shown in Table-3 and Figure-4, which showed that this plant has 13 peaks for functional groups. Based on the results obtained from spectroscopy, it was found that *P. oleracea* has 13 spectra including O-H, O-H, N-H, C=O, C=N, C=C, C-H, S=O, C-H, C-H, C-O, C=C, and C-H groups.

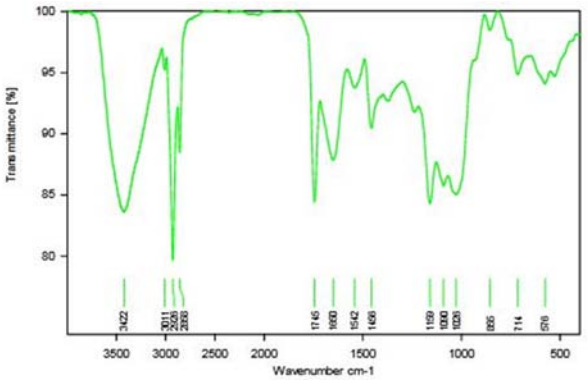

Figure 4. FTIR chromatogram of the seeds of *Portulaca oleracea*

13 spectra including O-H, O-H, N-H, C=O, C=N, C=C, C-H, S=O, C-H, C-H, C-O, C=C, and C-H has been shown.

Table 2. Spectroscopy of *Kelussia odoratissima*, wavelength, the functional group and their types

Wave number (cm^{-1})	Frequency range	Functional group	Vibration type
3414	3400-3500	N-H	Stretching- Primary Amine
2926	2840-3000	C-H	Stretching- Alkan
2856	2840-3000	C-H	Stretching- Alkan
1745	1735-1750	C=O	Stretching- Ester
1642	1640-1690	C=N	Stretching- Imine/Oxime
1454	1450-1465	C-H	Bending- Alkan
1245	1020-1250	C-N	Stretching- Amine
1047	1030-1070	S=O	Stretching- Sulfoxide
608	515-690	C-Br	Stretching- Halide Compound

Table 3. Spectroscopy of *Portulaca*, wavelength, the functional group and their types

Wave Number (cm^{-1})	Frequency Range	Functional Group	Vibration Type
3422	3200-3550	O-H	Stretching- Alcohol
3011	2700-3200	O-H	Stretching- Alcohol
2926	2800-3000	N-H	Stretching- Amine salt
2868	2800-3000	N-H	Stretching- Amine salt
1745	1735-1750	C=O	Stretching- Lactone
1660	1640-1690	C=N	Bending- Imine/Oxime
1542	1638-1648	C=C	Stretching- Alkan
1456	1450-1465	C-H	Bending- Alkan
1150	1300-1350	S=O	Stretching- Sulfone
1026	1020-1075	C-O	Stretching- Alkyl aryl ether
866	860-880	C=C	Bending- Alkene
714	780±20	C-H	Bending- Substituent 1, 2, 3
576	755±20	C-H	Bending- Substituent 1, 2

Discussion

Medicinal plants are recognized for their phytochemical constituents those are responsible for numerous biological properties of herbs. *K. odoratissima* is a medicinal herb with edible and therapeutic purposes (Karimian et al., 2017). There are several pieces of evidence about the presence of numerous biological activities such as anti-bacterial, antioxidant, cytotoxic, anti-inflammatory, larvicidal, anti-leishmanial, spasmolytic, anti-hypertensive, anxiolytic, and sedative effects (Rabbani et al., 2011). A growing body of evidence have demonstrated that the essential oil of *K. odoratissima* has various kinds of phytochemical constituents including Sesquiterpene hydrocarbons, Non-terpenes, Ligustilide, Oxygenated monoterpenes, δ-Cadinene, Germacrene D, γ-Elemene, Neryl 2-methyl butanoate, Germacrene B, Monoterpene hydrocarbons, Lavandulyl isobutyrate, Butylidene phthalide, β-Phellandrene, α-Copaene, β-Elemene, and γ-Cadinene (Khanavi et al., 2021). *P. oleracea* or purslanes is a beneficial medicinal plants which is known for several therapeutic effects such as renoprotective activity, neuroactivity, muscle relaxant effects, metabolic effect, hepatoprotective effects, reducing abnormal uterine bleeding effects, antimicrobial effects, anti-fertility effect, gastric anti-ulcerogenic activity, anti-inflammatory and analgesic effects, and cytotoxic activity (Iranshahy et al., 2017). It has been also reported that *P. oleracea* has a wide range of chemical constituents such as flavonoids, polysaccharides, alkaloids, fatty acids, vitamins, terpenoids, organic acid, sterols, proteins, minerals and other types of natural chemical compounds (Petropoulos et al., 2016). Flavonoids are a main class of natural active compounds with numerous biological effects (Dias et al., 2021). There are several types of flavonoids in various parts of *P. oleracea* including Kaempferol, quercetin, myricetin, apigenin, and luteolin (Yan et al., 2012). Hence, the aim of the present study was to evaluate the functional groups presented in *K. odoratissima* and *P. oleracea* as two valuable herbs through FTIR analysis. The results obtained from FTIR analysis of the present study highlighted that *K. odoratissima* had 9 peaks for the functional groups. Furthermore, it was found that *K. odoratissima* has 9 spectra including N-H, C-H, C=O, C=N, C-H, C-N, S=O, and C-Br. To the best of our knowledge, it is possible that the present study be the first study to determine functional groups of *K. odoratissima*. However, researchers have confirmed the presence of various phytochemical constituents which are responsible for numerous biological properties of *K. odoratissima* especially the antioxidant effect (Akbarian et al., 2019). On the other hand, another part of our study revealed that *P. oleracea* has 13 peaks for functional groups. Based on the results obtained from spectroscopy, it was found that *P. oleracea* has 13 spectra including O-H, N-H, C=O, C=N, C=C, C-H, S=O, C-O, C=C and C-H groups. There are several lines of evidence about the presence of phytochemical constituents in *P. oleracea*. In a similar study conducted by H. Zhu and the colleagues, volatile oils extracted from eleven samples of *P. oleracea* were evaluated by FTIR. The results of their study showed that the FTIR peaks of *P. oleracea* were predominantly in the range of 1600–700cm^{-1}. Furthermore, the authors of this study reported the presence of the fifteen common peaksin all the FTIR spectra of *P. oleracea*. Moreover, the findings of the above mentioned study demonstrated that the stretching vibration of alcohol groups had a strong peak at 3305 cm^{-1}(7). In agreement with the results of the study conducted by H. Zhu and the colleagues, our study revealed that the stretching vibration of alcohol groups had a strong peak at3200-3550 cm^{-1}.

Conclusion

In conclusion, our findings demonstrated that *K. odoratissima* and *P. oleracea* have a wide range of functional groups. Hence, given the presence of various types of functional groups in these plants, many therapeutic properties such as antioxidant, antibacterial and anti-inflammatory effects can be listed for these plants. Taking together, further studies could be considered for the evaluation of various applications of these medicinal plants in medicine and pharmaceutical industries.

Conflict of interest

There is no conflict of interest.

Acknowledgement

The author is grateful to the Biotechnology and Medicinal Plants Research Center, Ilam University of Medical Sciences, Ilam, Iran.

Funding/support

None.

Authors' contributions

The author designed and carried out the study. She wrote the first draft of the manuscript and revised and confirmed the final version.

Ethical considerations

Ethical issues (including plagiarism, misconduct, data fabrication, falsification, double publication or submission, redundancy) have been completely observed by the author.

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