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Phytochemical Investigations From Polygonum Hydropiper, Laksa, And Dandelion

Tao-Liang Huang[1], Rong-Shing Chang[2], Rome-Ming Wu[3]
[1]MS student from Department of Safety, Health and Environmental Engineering, Ming Chi University of Technology, Taishan, New Taipei 24301, Taiwan, ROC
[2]PhD student from Master & PhD Program in Biotechnology Industry, Chang Gung University, 259 Wen-Hwa 1st Road, Kwei-Shan Dist, Tao-Yuan City 33302, Taiwan, ROC
[3]Professor from Center for Environmental Sustainability and Human Health, Ming Chi University of Technology, Taishan, New Taipei 24301, Taiwan, ROC
1st U10167031@o365.mcut.edu.tw; 2nd changtipo@hotmail.com ; 3rd jwu@mail.mcut.edu.tw
*Corresponding Author: jwu@mail.mcut.edu.tw

Abstract:*This study analyzes the major chemical constituents of two Polygonaceae plants and one Asteraceae plant using a water extraction method. The selected plants are Persicaria hydropiper (water pepper), Persicaria odorata (laksa leaf), and Taraxacum officinale (dandelion), chosen for their traditional use as liver-protective foods. The results indicate that the primary chemical compound in Persicaria hydropiper is rutin, in Persicaria odorata is miquelianin, and in Taraxacum officinale is neochlorogenic acid. These compounds—rutin, miquelianin, and neochlorogenic acid—exhibit significant antioxidant and anti-inflammatory functions and health benefits.*
Keywords: *Antioxidant, Dandelion, Hydropiper, Laksa, Neochlorogenic acid, rutin.*

I. INTRODUCTION

Plant extracts play a crucial role in the field of health supplements, as they effectively concentrate beneficial bioactive compounds found in plants—such as polyphenols, flavonoids, saponins, and chlorogenic acids. These natural substances offer a wide range of physiological functions, including antioxidant, anti-inflammatory, liver-protective, immune-modulating, and metabolic benefits, which contribute to health promotion and disease prevention. Compared to consuming raw plant materials, plant extracts provide a more stable, controllable, and concentrated form of active ingredients, ensuring consistent product quality and efficacy. Moreover, modern extraction techniques—such as aqueous extraction, ethanol extraction, and supercritical CO_2 extraction—can minimize impurities and reduce harmful residues, enhancing both safety and bioavailability. As a result, plant extraction not only improves the effectiveness of health supplements but also showcases the innovative potential of natural ingredients in product development.

Polygonum Hydropiper (PH) was first recorded in Tang Materia Medica [1], and the 1977 Edition of the Chinese Pharmacopoeia included the whole herb of Polygonum Hydropiper [2]. The antibacterial and antifungal effects of Polygonum hydropiper (L.) (PH) root extract in chloroform were evaluated against both bacteria and fungi using the disc diffusion method [3]. The powder of Polygonum leaves is green in color, has an aromatic fragrance, and tastes spicy with a slight bitterness. Its texture is granular and fibrous [4].

Laksa leaf, also known as Vietnamese coriander, is a herbaceous plant belonging to the Polygonaceae family and Persicaria genus. It is commonly used as a culinary herb in Southeast Asia, where its leaves are often added to various dishes. In Vietnamese cuisine, Vietnamese coriander is frequently used in salads or added to spring rolls for extra flavor. The extract is rich in essential oils, polyphenols, flavonoids, and antimicrobial compounds, offering antioxidant, anti-inflammatory, antibacterial, and digestive-supporting properties. Traditionally, laksa leaf has been used to relieve gastrointestinal discomfort, regulate gut microbiota, and clear internal heat, making it suitable for formulations targeting digestive health, internal cleansing, and metabolic or immune balance. Due to its distinctive aroma and established safety profile, laksa leaf extract can also serve as a natural flavor enhancer and functional ingredient in health foods and beverages, demonstrating strong potential for versatile applications.

Dandelion is a perennial herbaceous plant, growing 10–25 cm tall, containing white milky sap. The root is deep and long, either single or branched, with a yellow-brown outer skin. Dandelion extract is widely

used in the field of health supplements, as its roots, leaves, and flowers contain various bioactive compounds such as chlorogenic acid, flavonoids (e.g., quercetin), triterpenes, and polyphenols. These components exhibit antioxidant, anti-inflammatory, choleretic, hepatoprotective, and mild laxative effects. Dandelion extract is commonly incorporated into formulations for liver detoxification, digestive support, women's health, and metabolic balance. It is especially effective when combined with other natural ingredients that promote detoxification or diuresis, enhancing overall efficacy. With a long history of safe consumption, dandelion is often formulated into capsules, powders, functional beverages, or multi-ingredient blends for daily health maintenance. Its versatility and natural efficacy make it a valuable ingredient in modern health product development.

Phytochemical analysis of the plant material revealed the presence of a broad spectrum of bioactive compounds including carbohydrates, glycosides, phenolic compounds, α-amino acids, flavonoids, steroids, terpenoids, as well as essential nutritional components such as moisture, ash, protein, fat, and fiber. Notably, the tests showed the absence of certain constituents such as alkaloids, saponins, tannins, starch, and cyanogenic glycosides, which can be relevant in assessing the safety and therapeutic profile of the extract [4]. In particular, Polygonum hydropiper (PH) is rich in a variety of phytochemicals that contribute to its medicinal properties. These include flavanol groups such as catechins, proanthocyanidins, and condensed tannins, known for their strong antioxidant and tumor-suppressing activities [5]. Beyond these, PH contains several other bioactive compounds including phenolic acids like gallic acid and ellagic acid derivatives, anthraquinones, aromatic 6-lactones, and a diverse range of flavonoids such as viscose acid, hydroxymethyl anthraquinone, rutin, hyperoside, epicatechin, quercetin, kaempferol, and isorhamnetin, each contributing various pharmacological effects such as anti-inflammatory, antimicrobial, and cardioprotective benefits [6]. This complex phytochemical profile underscores the potential of Polygonum hydropiper as a valuable source for natural health products and warrants further research into its therapeutic applications.

So far, 324 compounds have been isolated and identified from PH. Researchers have employed various separation techniques to isolate and purify the chemical components of PH, including flavonoids (12%), phenylpropanoids (3%), volatile oils (52%), terpenoids (23%), organic acids (6%), sterols (2%), and other compounds [2]. It has been reported that Polygonum hydropiper contains a diverse and complex mixture of bioactive compounds, including hydroquinone, 4-methylthiazole, caryophyllene, succinimide, vanillic acid, myristic acid, acacia alcohol, arachidonic acid methyl ester, and capsaicin [7]–[9]. These constituents contribute to the plant's characteristic aroma, pharmacological properties, and therapeutic potential. To date, researchers have isolated and identified a total of 324 distinct chemical compounds from Polygonum hydropiper (PH), reflecting its rich phytochemical diversity. Various advanced separation and purification techniques—such as column chromatography, high-performance liquid chromatography (HPLC), gas chromatography-mass spectrometry (GC-MS), and nuclear magnetic resonance (NMR) spectroscopy—have been employed to characterize these components.

Among these compounds, flavonoids constitute about 12% of the total chemical profile, known for their potent antioxidant, anti-inflammatory, and anticancer activities. Phenylpropanoids account for approximately 3%, contributing to antimicrobial and neuroprotective effects. The volatile oils represent the largest fraction at 52%, responsible for the plant's distinctive scent and many bioactivities including antimicrobial, insecticidal, and anti-inflammatory actions. Terpenoids make up around 23%, offering a wide range of pharmacological benefits such as hepatoprotection, immune modulation, and cytotoxicity against cancer cells. Organic acids, comprising about 6%, play roles in metabolic regulation and antioxidation, while sterols at 2% contribute to cardiovascular health by modulating cholesterol metabolism. The remaining minor constituents include alkaloids, polysaccharides, and other secondary metabolites that synergistically enhance the therapeutic potential of PH.

This extensive phytochemical complexity not only explains the traditional medicinal uses of Polygonum hydropiper but also provides a valuable chemical reservoir for the development of novel natural drugs, functional foods, and health supplements. Ongoing research continues to explore the bioactivities and mechanisms of action of these compounds, aiming to unlock further pharmacological applications and optimize extraction and formulation methods.

The hydrogen-donating substituent (hydroxyl group) attached to the aromatic ring structure of flavonoids enables them to undergo redox reactions, helping them more effectively scavenge free radicals. The presence of certain structural groups enables the formation of transition metal chelate complexes, thereby

regulating the production of reactive oxygen species, such as OH^- and O_2^{2-} [10].
Some pathological studies have found a positive correlation between the intake of kaempferol and a reduction in the incidence of various diseases, such as cancer and cardiovascular diseases. [11] Numerous preclinical studies indicate that kaempferol and certain kaempferol glycosides exhibit broad pharmacological activities, including antioxidant, anti-inflammatory, antimicrobial, anticancer, cardioprotective, neuroprotective, antidiabetic, anti-osteoporotic, anti-estrogenic, anxiolytic, analgesic, and anti-allergic effects [12].
An 8-year study found that kaempferol, quercetin, and myricetin can reduce the risk of pancreatic cancer in smokers [13]. The intake of kaempferol also lowers the incidence of lung cancer [14].
Vietnamese coriander (Persicaria odorata), also known as Vietnamese cilantro or laksa leaf, is an aromatic herb belonging to the Persicaria genus in the Polygonaceae family. In Southeast Asia, its leaves are commonly used in cooking. This plant serves as a valuable resource for antidiabetic, antibacterial, and antioxidant applications across various industries, including food, pharmaceuticals, and cosmetics. [15] Quantitative phytochemical analysis revealed that the stem of Polygonum hydropiper L. contains higher levels of bioactive compounds than its leaves. [15] The Polygonaceae family consists of 48 genera and approximately 1,200 species [16-17]. This species demonstrates anti-inflammatory properties [4] and insecticidal activity [10], as well as potential in anticholinesterase, phytotoxic, anthelmintic, antiangiogenic, anticancer, antimicrobial, and antioxidant effects [18].
Quercetin is a flavonoid found in fruits and vegetables, exhibiting potent antioxidant activity both in vitro and in vivo [19]. Studies have claimed that quercetin possesses various biological activities [20]-[23]. Yorozu et al. highlight the strong β-amylase inhibitory potential of P. Hydropiper and reveals its potential as a powerful source for future diabetes treatment drugs [8].
This study selected three plants—Hydropiper, Laksa, and Dandelion—to analyze the content of four compounds: Neochlorogenic acid, Chlorogenic acid, Miquelianin, and Rutin. Neochlorogenic acid, chlorogenic acid, miquelianin, and rutin are natural plant compounds with strong antioxidant and anti-inflammatory activities. Neochlorogenic acid not only helps reduce cellular damage caused by free radicals but also shows potential in regulating blood sugar, lowering cardiovascular disease risk, and protecting the liver. Chlorogenic acid is widely used to improve blood sugar control, reduce blood pressure, promote lipid metabolism, and support weight management, while also possessing neuroprotective and anticancer properties. Miquelianin, a water-soluble flavonoid, enhances cardiovascular health, slows neurodegeneration, and modulates immune responses. Rutin is known for strengthening blood vessel walls, improving blood circulation, and preventing vascular fragility; it is commonly used to treat varicose veins and related vascular conditions, and also demonstrates anti-allergic and antitumor potential. The combined effects of these compounds make them important agents in the prevention and adjunctive treatment of various chronic diseases.

II. EXPERIMENTS

The plants used in this experiment are water pepper (Polygonum hydropiper), laksa leaf (Persicaria odorata), and dandelion (Taraxacum officinale), as shown in **Figure 1**.
Wash the Polygonum leaves thoroughly with water and cut them into small pieces. Then, air-dry these samples in a cool, shaded place at room temperature for one to two weeks. Once completely dried, grind the samples into powder using a grinder and store them in a sealed container for further study.
Place 2-3 grams of the ground herbal sample (average diameter about 1.5 mm) into a stainless steel extraction cell that is 100 mm in length and has an internal diameter of 35 mm. Subsequently, position the extraction cell in a constant temperature heater and heat at 100°C for 50 minutes. The results are presented in **Table 1**. The experimental procedure is shown in **Figure 2**.
Liquid Chromatography–Tandem Mass Spectrometry (LC/MS-MS) is a highly sensitive and selective analytical technique that combines the principles of liquid chromatography (LC) and mass spectrometry (MS). In the first stage, liquid chromatography separates the compounds in a sample based on properties such as polarity, hydrophobicity, or other chemical characteristics. The separated compounds then enter the mass spectrometer, where they are ionized—typically by electrospray ionization (ESI)—to form charged molecules. These ions are analyzed by the first mass analyzer (MS1), which selects specific precursor (parent) ions. These selected ions then undergo collision-induced dissociation (CID), breaking into characteristic fragment (product) ions that are analyzed by the second mass analyzer (MS2) for both

qualitative and quantitative analysis. This technique is especially well-suited for detecting trace compounds in complex matrices—such as drug residues, metabolites, or plant-derived bioactive compounds—offering excellent sensitivity, specificity, and analytical reliability.

TABLE I LC-MS/MS RESULTS OF HERBAL PLANTS EXTRACTS

	H	L	D
Neochlorogenic acid	0.41	–	0.44
Chlorogenic acid	0.38	0.10	0.23
Miquelianin	2.07	2.40	–
Rutin	3.24	–	–

Fig. 1. The herbal plants used in this experiment (from left to right, Polygonum hydropiper, laksa, and dandelion)

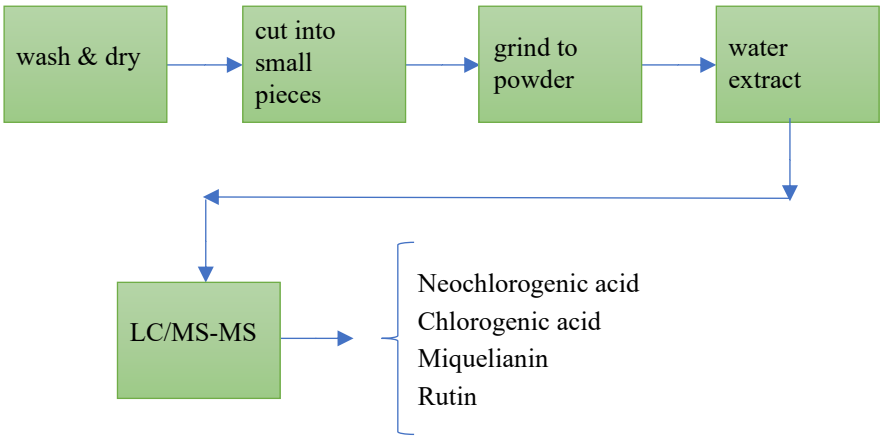

FIG. 2. EXPERIMENTAL PROCEDURE

III. RESULTS AND DISCUSSION

From the results shown in Table 1, which are also illustrated in **Figure 3**, it can be clearly observed that Polygonum hydropiper L. contains significant amounts of phenolic compounds, including neochlorogenic acid and chlorogenic acid, with concentrations measured at 0.41 mg and 0.38 mg per gram of dried plant material, respectively. These acids are well-known for their antioxidant properties and contribute to the plant's health-promoting effects. In addition to these phenolic acids, Polygonum

hydropiper L. is notably rich in flavonoids, particularly Miquelianin and Rutin, with concentrations of 2.07 mg and 3.24 mg per gram of dried plant, respectively. The presence of these flavonoids is important due to their anti-inflammatory, antiviral, and vascular protective effects.

On the other hand, Laksa leaf exhibits a different phytochemical profile, containing chlorogenic acid and Miquelianin at concentrations of 0.10 mg and 2.40 mg per gram of dried plant, respectively. Although the chlorogenic acid content in Laksa is lower compared to Polygonum hydropiper L., the substantial amount of Miquelianin still suggests promising biological activity. Meanwhile, Dandelion contains neochlorogenic acid and chlorogenic acid, with concentrations of 0.44 mg and 0.23 mg per gram of dried plant, respectively, indicating a moderate presence of these phenolic acids.

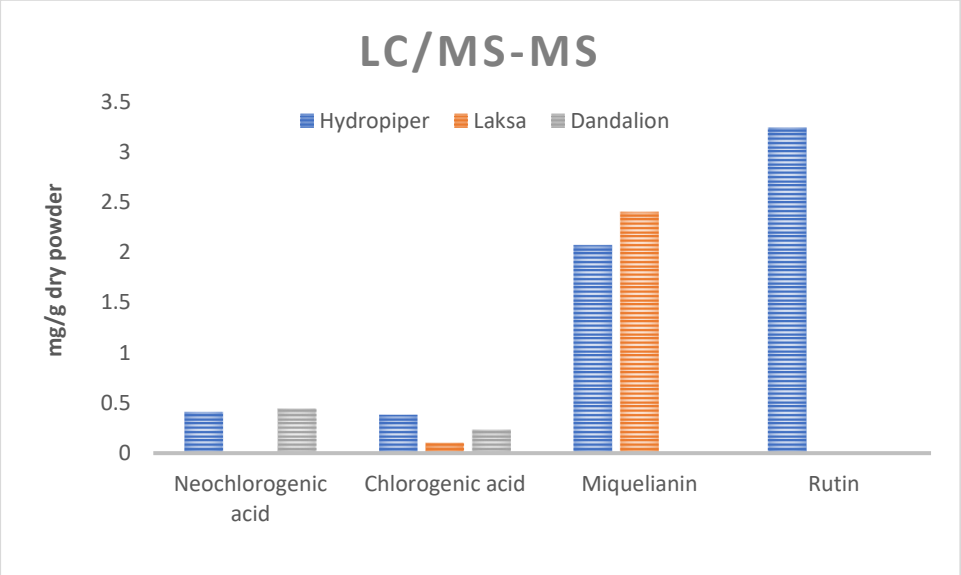

FIG. 3. LC-MS/MS RESULTS OF HERBAL PLANTS EXTRACTS

Both Miquelianin and Rutin belong to the flavonoid class, which are recognized for their diverse pharmacological properties including antioxidant, cardioprotective, and anti-cancer activities. The combined content of these two flavonoids in Polygonum hydropiper L. reaches 5.31 mg per gram of dried plant in this study, underscoring the plant's richness in bioactive flavonoids. When compared to literature values, the total flavonoid content obtained from microwave-assisted extraction of Polygonum hydropiper L. was reported as 2.05 mg per gram of dried plant [24], while its chlorogenic acid content was approximately 0.40 mg per gram [24]. The chlorogenic acid content observed in the current study aligns closely with these previously reported values, but the flavonoid content measured here is significantly higher, suggesting that the extraction method used in this work may enhance the yield or preservation of flavonoids. This higher flavonoid content could potentially translate into greater biological efficacy, making Polygonum hydropiper L. an even more valuable candidate for natural health product development.

IV. CONCLUSIONS

The present study aimed to evaluate the predominant extractable substances from different plants, focusing on their potential health-promoting properties. To this end, three herbal plants were carefully selected based on their traditional uses and phytochemical profiles. Comprehensive phytochemical analysis revealed that among these, water pepper (Persicaria hydropiper) stands out as a particularly rich source of bioactive compounds, especially flavonoids and chlorogenic acid. These compounds are well-known for their potent antioxidant, anti-inflammatory, and antimicrobial activities, which contribute to various health benefits such as improved metabolic function and enhanced immune response. The high content of these phytochemicals in water pepper underscores its potential as a valuable ingredient in the development of functional foods and nutraceutical products. The reported data not only highlight the chemical richness of water pepper but also provide a scientific basis supporting its traditional use and

pave the way for further investigations into its therapeutic applications and formulation strategies in health supplements.

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