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Characterization of the Phytochemical Profile of *Petroselinum Crispum Leaves* in Central Kalimantan Habitat as a Basis for Pharmacological Potential Exploration

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Abstract

This study aimed to characterize the phytochemical profile of *Petroselinum crispum* leaves cultivated in Central Kalimantan as a basis for exploring their pharmacological potential. *P. crispum* is a horticultural commodity of high economic value, widely used both as a culinary spice and in traditional medicine, making it a promising candidate for further development. The analysis focused on flavonoids, tocopherols, ascorbic acid, and estrogen content, using UV-Vis spectrophotometry. Results showed that flavonoid concentrations increased with higher quercetin standards, reaching a maximum of 0.92 mgQE/g at 100 µg/mL. In contrast, tocopherol and ascorbic acid levels declined as quercetin concentrations increased, suggesting that the compounds may have undergone degradation or interaction. Estrogen levels were recorded at 28.40 ng/mL with an absorbance of 0.498 and a regression equation of $y = 0.0173x + 0.007$ ($R^2 = 0.998$). The substantial flavonoid content and detectable estrogenic activity highlight *P. crispum* as a potential source of natural active compounds for antioxidant and hormonal therapy. These findings support the recommendation of *P. crispum* as a raw material for developing safe, affordable, and effective herbal supplements and phytopharmaceuticals to promote public health.

Keywords: Central Kalimantan, Characterization, *Petroselinum crispum*, Pharmacological, Phytochemical Profile

1. Introduction

Indonesia possesses the second-highest biodiversity in the world after Brazil (Lestri, 2016; Hujjatusnaini et al., 2021). Of an estimated 30,000–50,000 plant species, only about 7,500 have been identified as medicinal plants (Khafid et al., 2023; Hujjatusnaini et al., 2024). The use of plants for medicinal purposes has long been an integral part of Indonesian culture, either in the form of herbal decoctions or as food-based therapies. (Pane et al., 2021; Gustina et al., 2024 ; Bunga et al., 2025) , which is more often consumed in the form of herbal decoction (Noer, 2016; Puspitasari et al., 2022).

The therapeutic value of medicinal plants largely derives from their secondary metabolites—bioactive compounds naturally produced as part of plant defense and adaptation mechanisms. These metabolites, which include flavonoids, alkaloids, tannins, triterpenoids, steroids, and saponins, not only protect plants from environmental stress but also represent key resources for drug discovery (Rachmawan & Dalimunthe, 2017; Nasrul & Chatri, 2024). Secondary metabolites play an important role not only as a natural defense system for plants against environmental stress, but also as a major source for the development of new drugs. (Khafid et al., 2023) . Various compounds such as flavonoids, alkaloids, tannins, triterpenoids, steroids, and saponins are known to have promising pharmacological activities. (Luringunusa et al., 2023) .

Therefore, phytochemical testing, both qualitatively and quantitatively, is an important initial step in identifying bioactive compounds in plants. This test provides information on whether plant extracts have therapeutic potential or exhibit certain toxic effects when tested in biological systems (Hutasuhut et al., 2022; Wardhani et al., 2018). The identification of secondary metabolite compounds from various plant species, particularly leaves, can provide a deeper understanding of the benefits and

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potential applications of these plants (Khafid et al., 2023). Several leaf plants have been utilized and are known to contain metabolites that are beneficial to humans (Khafid et al., 2023; Nurlita et al., 2024).

One plant that has great potential in this regard is parsley (Petroselinum crispum), an aromatic plant from the Apiaceae family that has been widely cultivated in tropical and subtropical regions (Bimmaharyanto et al., 2022). In addition to being used as a culinary ingredient, parsley leaves and roots (Petroselinum crispum) are also beneficial for treating urinary tract and digestive tract disorders. Previous research has also shown that Petroselinum crispum exhibits broad biological activities, including cytoprotective, antidiabetic, antioxidant, antifungal, anti-inflammatory, and anticancer properties (Cahyono & Suzery, 2020; Prasiska Wulandari et al., 2023). These activities are very likely related to the content of secondary metabolites, especially flavonoids and phenolic compounds.

However, the local phytochemical characterization of Petroselinum crispum, especially from tropical regions such as Indonesia, has been limited. This finding is despite geographical factors, climate, and local cultivation conditions influencing variations in bioactive compound content in plants. Previous research by El-Sayed et al. (2018) described the flavonoid content in *P. crispum leaves*, which acts as an antioxidant. Meanwhile, Ertas et al. (2021) emphasized the role of tocopherol in anti-inflammatory activity. These studies did not specifically examine the ascorbic acid and estrogen content in relation to pharmacological activity. Therefore, this study considers it important not only to identify phytochemicals in general, but also to conduct further analysis of specific compounds that have direct therapeutic effects, such as total flavonoids, estrogen, tocopherol, progestin, and ascorbic acid. Flavonoids are known to be the main antioxidants that play a role in neutralizing free radicals and supporting cell health; estrogen and progestin compounds have the potential to regulate reproductive hormones; tocopherol (vitamin E) has an important role as a cell protector from oxidative damage; while ascorbic acid (vitamin C) not only functions as an antioxidant but also strengthens the immune system and tissue collagen.

The comprehensive profiling of these compounds is essential to evaluate the pharmacological potential of *P. crispum* as a source of bioactive ingredients. Findings from this study are expected to advance the application of this substance as a health supplement, traditional remedy, and raw material for modern phytopharmaceuticals. Furthermore, the results aim to support the development of *P. crispum* as a high-value tropical resource and expand its utilization in the herbal health industry of Central Kalimantan.

2. Material and Methods

This research was conducted using an exploratory survey approach, involving direct observation of plant morphology. Sampling employed a purposive sampling method to identify areas considered relevant and representative based on specific criteria. The sampling location was in the Kuala Pembuang area, Seruyan Hilir District, Seruyan Regency, Central Kalimantan, at coordinates 3.3874°S and 112.5434°E, with an altitude of approximately 5 meters above sea level.

Figure 1. Research sampling location

This research was conducted from May to July 2025. Research on the analysis of morphology and secondary metabolite compounds of plants was carried out in the Microbiology Laboratory at the Biology Education Department, State Islamic Institute of Palangka Raya. The method used enables researchers to obtain more accurate data regarding the physical characteristics and morphology of the Petroselinum crispum plant.

This research began with a literature review aimed at exploring various scientific literature on *Petroselinum crispum*, particularly those related to its phytochemical, morphological, and therapeutic potential. This process involved searching through reliable sources, including scientific journals, textbooks, and previous research findings. The researchers aimed to gain a comprehensive understanding of the plant's agronomic and pharmacological value, while also identifying research gaps that could serve as a basis for future studies. In formulating the focus of the researcher's study. The stages of research implementation are outlined in the flowchart shown in Figure 2.

The identification and formulation of the problem were based on the results of a literature review and initial field observations. The primary issue addressed in this study concerns the need to investigate the morphological characteristics and phytochemical compounds of *Petroselinum crispum* growing in Central Kalimantan. The assumption that local geographic and environmental conditions can influence the expression of secondary metabolites in this plant underlies the importance of this research. The research direction was designed to address these issues in a scientific and systematic manner.

After formulating the problem, the researcher set three research objectives, namely: (1) describing the morphological characteristics of *Petroselinum crispum* growing in Central Kalimantan, (2) identifying the content

of phytochemical compounds such as flavonoids, alkaloids, saponins, and tannins. (3) assessing the potential of this plant as a source of natural ingredients that can be developed for alternative therapy, especially in relation to the fertility index.

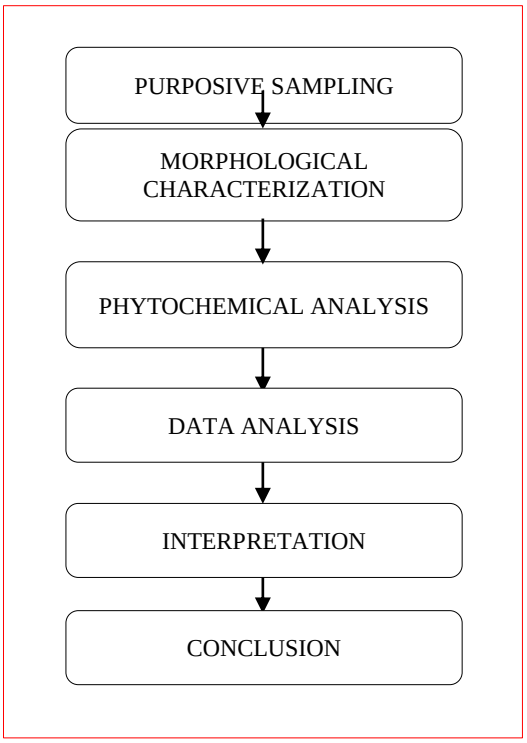

Figure 2. Research flow diagram

Petroselinum crispum leaf samples were collected directly from their natural habitat in Central Kalimantan. Sampling was carried out through a process of taxonomic identification in the field, followed by the selection of representative leaves from several different locations, and recording the environmental conditions in which the plants grow. The collected leaves were then dried and stored according to established procedures to prevent damage or degradation of the active compounds before further analysis.

The final stages of this research included morphological and phytochemical analyses. Morphological observations were conducted by assessing various physical characteristics of the plant, such as leaf shape and size, color, surface texture, and stem and flower characteristics, if present. Phytochemical analyses were also conducted qualitatively to identify the presence of bioactive compounds. Tests were conducted using test tube methods, including alkaloid testing with Mayer or Dragendorff reagents, flavonoid testing with the Shinoda method, tannin testing using gelatin solution, saponin testing using the foam test, and terpenoid and steroid testing with the Liebermann-Burchard method.

Petroselinum crispum leaf extract begins with the analysis of the total amount of flavonoids using the aluminum chloride ($AlCl_3$) complexation method. The extract is reacted stepwise at a certain concentration (e.g., 1 mg/mL in 70% ethanol) with sodium nitrite ($NaNO_2$), aluminum chloride ($AlCl_3$), and sodium hydroxide (NaOH) solutions, and then diluted to 10 mL. After being left for 15 minutes, the absorbance is measured at a wavelength of 415 nm using a spectrophotometer. Flavonoid levels are calculated based on a quercetin standard curve, and the results are expressed in mg quercetin equivalents (QE) per gram of dry extract.

Estrogen and progestin hormone levels were measured separately using an enzyme-linked immunosorbent assay (ELISA) method based on specific antibodies. Extracts dissolved in the buffer or solvent recommended by the ELISA kit were placed into microtiter wells along with the antibody reagents. After incubation, washing, and substrate addition, absorbance was measured at a wavelength of 450 nm. Estrogen and progestin levels were determined using standard curves for each hormone, and results were expressed in ng/mL or µg/mL depending on the kit format.

Examination of tocopherol (vitamin E) content can be performed using simple spectrophotometry with the DPPH (2,2-diphenyl-1-picrylhydrazyl) reagent as an indicator of antioxidant activity (Mubarak et al., 2017). The extract sample was mixed with the DPPH solution and incubated in the dark for 30 minutes. The absorbance was then measured at 517 nm. (Lung & Destiani, 2017) . The decrease in absorbance compared to the blank DPPH solution indicates tocopherol reduction activity. (Putri, 2023) . The measurement results were compared with the α-tocopherol standard curve. A more accurate alternative for tocopherol analysis is the high-performance liquid chromatography (HPLC) method, which utilizes a C18 column and a methanol:water (95:5) mobile phase, along with UV detection at 292 nm.

Tocopherol analysis was performed using high-performance liquid chromatography (HPLC) with an isocratic system, comprising a high-pressure pump, a C18 column (250 × 4.6 mm, 5 µm), and a methanol: water (95:5) mobile phase. A 20 µL sample was injected and detected using a UV-Vis detector at a wavelength of 292 nm, corresponding to the maximum absorption of tocopherol. Chromatogram data were analyzed using specialized software to calculate concentrations based on a standard curve of α-tocopherol. This method is superior because it provides good separation, high sensitivity, and guaranteed accuracy and reproducibility (Zhong & Shahidi, 2015; Ahn-Jarvis et al., 2018).

Ascorbic acid levels were analyzed using a spectrophotometric method based on a reaction with 2,6-dichlorophenolindophenol (DCPIP) reagent. In this procedure, *Petroselinum crispum extract* was reacted with DCPIP solution, and the color change of the solution from blue to colorless was measured at a wavelength of 520 nm using a UV-Vis spectrophotometer (Shimadzu UV-1800).

The decrease in absorbance reflects the reducing activity of ascorbic acid in the sample. The absorbance measurement data were then analyzed using a linear regression equation of the ascorbic acid standard curve to calculate the concentration, with data processing carried out using the spectrophotometer's built-in software or statistical applications such as Microsoft Excel/Origin. Vitamin C levels were then expressed in milligrams per gram of extract.

3. Results and Discussion

This section presents the results of the morphological characterization of *Petroselinum crispum plants* observed directly in the field. Observations focused on the plant's main organs, including roots, stems, leaves, flowers, and fruit. Each part was observed based on established morphological indicators, such as color, shape, size, texture, and structure. Visual data in the form of photographic documentation was used to strengthen the observations and provide a more comprehensive picture. Figure 3 below shows the main parts of the *Petroselinum crispum plant.*

Petroselinum crispum, widely known as curly celery or parsley, is a biennial herb from the Apiaceae family. It originates from the Mediterranean region and is now widely cultivated in various countries, including Indonesia, both as a horticultural crop and as a medicinal plant (Rafiee et al., 2016). *P. crispum* has high economic and nutritional value because its leaves are widely used as a cooking spice, while its roots are also used in several dishes and herbal concoctions.

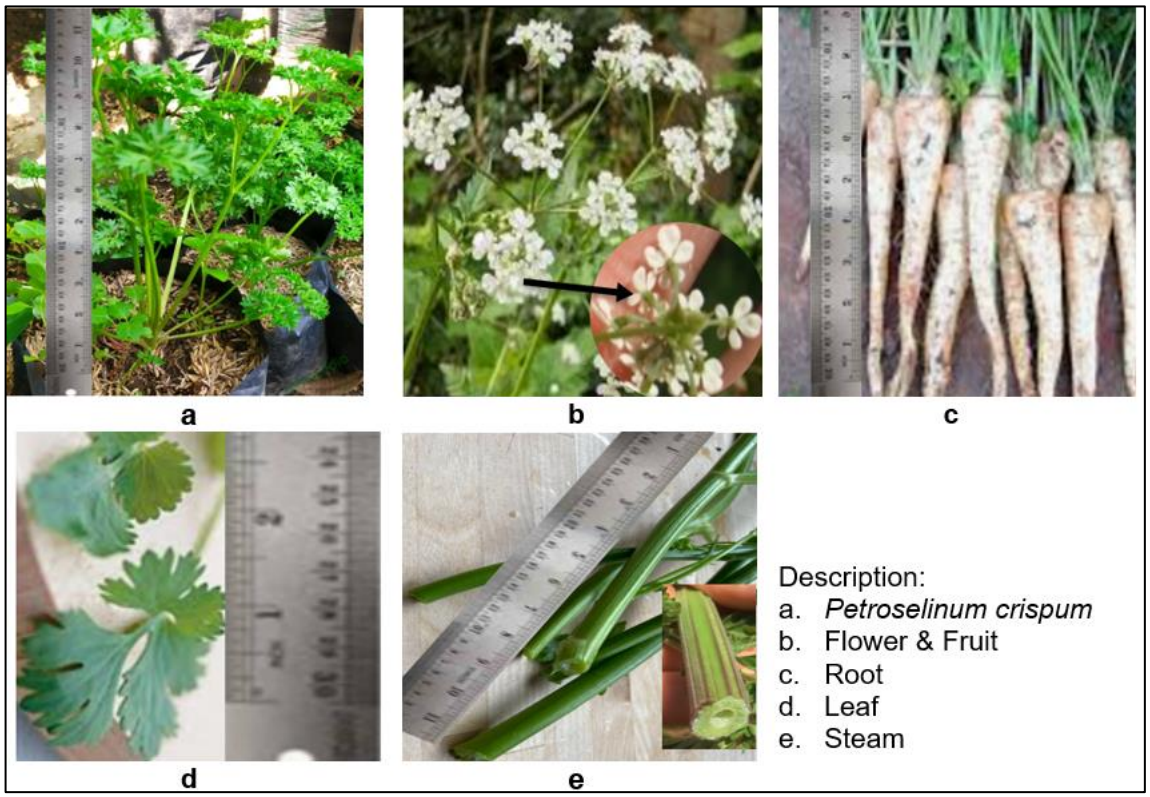

Figure 3. Main parts of the *Petroselinum crispum* plant.

P. crispum has distinctive morphological characteristics. Its leaves are bright green, pinnately compound, and deeply lobed. The stem is upright, cylindrical, and strong enough to support the leaf canopy. The root system consists of a taproot with lateral branches, which can enlarge, especially in root varieties. This plant also produces small, yellowish-white flowers arranged in compound umbels, which later develop into small, flat seeds (Pites et al., 2020). Besides its aesthetic and culinary value, this plant is also known to possess various pharmacological properties.

Several studies have shown that *P. crispum* contains active compounds, including flavonoids, vitamin C, apiol, and myristicin, which have potential as antioxidants, anti-inflammatory agents, diuretics, and antimicrobials (Maldini et al., 2017; Ghasemi et al., 2021; Subaş et al., 2024). Therefore, this plant is often used in traditional medicine to help overcome digestive disorders, inflammation, urinary tract infections, and as a diuretic. Based on field observations, the following table presents the morphological characterization of the *Petroselinum crispum plant* as a basis for further analysis and discussion.

Table 1. Morphological Characteristics of *Petroselinum crispum*

Organ	Organ Character	Morphological Characteristics
Root	Root Color	White to creamy yellow
	Root Form	Taproot, extending downwards
	Root Type	Taproot system
	Root Structure	Epidermis, cortex, central cylinder, root hairs
	Root Texture	Fine to slightly coarse
	Main Root Length	15–25 cm
	Lateral Root Length	5–10 cm
	Root Diameter	1–2 cm (leaf varieties), up to 5 cm (root varieties)
Stem	Bar Color	Light green to dark green
	Stem Shape	Cylindrical, upright
	Stem Diameter	0.2–0.5 cm
	Stem Length	15–30 cm
	Stem Surface	Smooth, hairless
	Internodes	Short, about 1–3 cm
	Node Book	It is clearly visible where the leaves and branches grow.
	Branching	Growing from leaf axils, branching a lot
	Stem Strength	Flexible but strong enough to support leaf crowns
Leaf	Leaf Color	Fresh green, shiny
	Leaf Shape	Compound pinnate, deeply cupped
	Leaf Tip	Pointed or rounded, depending on the variety
	Leaf stalk (Petiole)	5–15 cm long, cylindrical
	Leaf Edge	Serrated or deeply grooved
	Leaf Bones	Pinnate, clearly visible
	Leaf Width	About 1–3 cm per leaflet
	Leaf Length	3–10 cm per leaflet
	Leaf Surface	Smooth, shiny, hairless
	Leaf Type	Compound leaves
	Leaf Base	Tapered or rounded
	Leaf Arrangement	Alternate
	Leaf Texture	A bit thick, but flexible and not stiff
Flowers & Seeds	Flower	Small, yellowish white, arranged in compound umbrellas (umbels)
	Seed	Small, flat oval, light brown when dry

3.1. Root Morphology

The morphological characteristics of *P. crispum roots are white to creamy yellow, exhibit*ing pigment variations common in non-photosynthetic root systems. The root shape is a taproot that extends downwards, with a type of root system that plays an important role in supporting the upright plant and absorbing water from deeper soil layers. The root structure is composed of epidermal tissue, cortex, and a central cylinder, and it has root hairs that facilitate the absorption of nutrients and water. Root texture varies from smooth to slightly rough, depending on the variety and age of the plant. The length of the main root ranges from 15 to 25 cm, while the length of the lateral roots is between 5 and 10 cm. Root diameter varies based on the variety, ranging from 1–2 cm in leaf varieties to 5 cm in root varieties.

The morphological characteristics of *P. crispum roots* are strongly influenced by their variety. Leaf varieties typically have smaller roots because growth is more focused on the leaves, while root varieties have an enlarged taproot and are used as a food source. A taproot with a deep root system enables the plant to absorb water efficiently, especially in dry areas (Petropoulos, 2016). A complete root network structure, including the presence of root hairs, significantly enhances the plant's ability to adapt to its environment and increases nutrient absorption from the soil.

The white to cream color of the roots indicates the degree of maturity and the content of certain compounds, such as furanocoumarins and flavonoids, which are reported to be present in parsley roots and have certain biological effects, including anti-inflammatory and diuretic properties. (Upton, 2001) . The varying texture of roots is also an indicator of growing conditions, where roots growing in loose soil tend to be smooth, while those growing in dense soil can be rougher. Understanding the morphological characteristics of roots is useful in cultivating *P. crispum*, especially in determining varieties suitable for consumption or medicinal purposes.

3.2. Stem Morphology

The stem organs *of P. crispum* exhibit a distinctive morphology that supports its growth as a biennial herb. The stem color varies from light green to dark green, indicating direct photosynthetic activity in the stem tissue due to the presence of chlorophyll therein. (Salisbury & Ross, 2019) . The cylindrical and upright stem shape is a common characteristic in dicotyledonous plants, which allows for the optimal distribution of water and nutrients from the roots to the leaves. (Taiz et al., 2015) . Stem diameter ranges from 0.2 to 0.5 cm with a length of 15 to 30 cm, reflecting moderate growth in accordance with the habitus of annual or biennial plants with tap roots.

The stem surface is generally smooth and hairless, which reduces the risk of excessive evaporation and minimizes inhibition of photosynthesis. Internodes are relatively short, measuring only about 1–3 cm, which gives the plant a compact and dense appearance —a characteristic often found in aromatic horticultural crops, such as celery and parsley (Heuzé et al., 2016). Nodes are clearly visible and serve as the growth points for leaves and branches. Stem branching is axillary, originating from leaf axils, and is highly branched, indicating strong lateral growth potential and allowing for the formation of a dense canopy.

The stems of *P. crispum* are flexible yet strong enough to support a dense canopy of leaves. This flexibility also enables the leaves to adjust their position relative to the light, thereby increasing their efficiency in capturing sunlight. (Lambers et al., 2008) . Stem morphological characteristics support plant adaptation. To the growing environment and contribute to leaf biomass production.

3.3. Leaf Morphology

The P. crispum plant are fresh green with a glossy surface. The shape of the leaves is pinnately compound and deeply lobed, with leaf tips varying in shape, ranging from pointed to rounded, depending on the variety. The petiole is cylindrical, measuring between 5–15 cm in length. The leaf edges are serrated or deeply notched, and the leaf veins are pinnate and clearly visible. The width of the leaves ranges from 1–3 cm per leaflet, while the length is between 3–10 cm per leaflet. The leaf surface is smooth, glossy, and hairless. The leaves are classified as compound type, with a pointed or rounded base, and are arranged alternately. The leaf texture is rather thick but flexible and not stiff.

P. crispum leaves are a prominent part of the plant due to their role in photosynthesis and use as a culinary ingredient and source of bioactive compounds. The leaves are a fresh, glossy green, indicating high chlorophyll content and healthy photosynthetic tissue. The leaves are pinnately compound with deep branching, suggesting adaptation for efficient light capture (Thomas et al., 2016). The leaf tips vary from pointed to rounded, depending on the variety, which is one of the morphological indicators used in identifying *P. crispum cultivars.* (Oktay et al., 2021) .

The petiole is 5–15 cm long and cylindrical, enabling the leaf to flexibly adjust to changes in light. The leaf margins are serrated or deeply notched, increasing the surface area for transpiration and gas exchange. The leaf veins are pinnate and clearly visible, supporting efficient water transport and photosynthesis (González & Syvertsen, 2008).

The leaves of *P. crispum* are relatively small, measuring between 1–3 cm wide and 3–10 cm long per leaflet, demonstrating the herb's adaptation to temperate to subtropical habitats. The smooth, glossy, and hairless leaf surface indicates a thin cuticle that functions to reduce water loss while still allowing optimal respiration. The leaves are arranged alternately, which helps prevent overlap and increases the efficiency of light exchange between leaves.

The leaf texture is quite thick yet remains flexible, not stiff, reflecting a balance between structural strength and flexibility in adapting to microenvironmental conditions. *P. crispum leaves* are also known to contain secondary metabolites such as flavonoids, essential oils, and phenolic acids, which are highly concentrated in leaf tissue, making it an important part of the plant from a phytochemical and pharmacological perspective (Zeković et al., 2022).

3.4. Flower and Seed Morphology

The flowers of this plant are small, yellowish-white, and arranged in compound umbrella-shaped inflorescences (*umbels*), a typical inflorescence form in the Apiaceae family. This floral structure serves to attract pollinating insects, which tend to visit flowers in dense clusters. Recent research has shown that compound inflorescences in Apiaceae plants enhance pollination efficiency by small insects, such as flies and bees, that are active in open ecosystems (Gómez et al., 2020).

The seeds are small, flattened, and light brown when dry. This seed shape and size suggest a possible dispersal mechanism that relies on wind or small animals. A study conducted by (2019) found that small and light seeds of some Apiaceae species exhibit a high tendency for long-distance dispersal by wind and attachment to the bodies of small animals (epizoochory).

The flower and seed structures suggest that this plant has an efficient generative reproductive strategy. Compound flowers facilitate cross-pollination, *while* small, aerodynamically shaped seeds support widespread dispersal and successful colonization of new areas. This strategy is relevant to theories of flowering plant reproduction that emphasize dispersal efficiency as a key factor in species adaptation and survival. (Moles et al., 2014) .

The characterization of the phytochemical profile of the *P. Crispum plant* is presented in Table 2 to strengthen the information about its pharmacological benefits.

Table 2. Characterization of the Phytochemical Profile *of P. crispum*

Parameters	Phytochemical Characterization	*Petroselinum crispum*
Flavonoid	Orange, yellow, dark red	(+)
Meyer	White colored preparation	(-)
Drgondrof	Orange colored preparation	(+)
Bouchardat	Brown colored preparation	(-)
Tannins/phenols	Blue, blackish green, blackish blue	(+)
Steroid	bluish green	(-)
Triterpenoid	Reddish brown	(+)
Saponin	Permanent foam	(-)

Phytochemical test results showed that *P. crispum extract* contains several secondary metabolite compounds, indicated by color changes or precipitation formation depending on the reagent used. The flavonoid test yielded positive results, with color changes ranging from orange to yellow and even dark red, indicating the presence of flavonoid compounds in the extract. Dragendorff's reagent also gave positive results with the appearance of an orange color, which supports the indication of the presence of alkaloids, although the results of the Mayer and Bouchardat tests showed negative results because no white or brown precipitate was formed.

Phenolic and tannin compounds were detected by a blue-black color change, indicating a positive reaction to the tannin/phenol test. In the terpenoid and steroid compound tests, the triterpenoid test yielded a positive result, indicated by a reddish-brown color, while the steroid test yielded a negative result due to the absence of a bluish-green color. The saponin test did not show any stable foam formation, thus categorizing it as negative, indicating the absence of saponins in the extract.

Overall, these results indicate that *P. crispum* contains flavonoids, alkaloids (detected by Dragendorff), tannins/phenols, and triterpenoids. *P. crispum leaves* did not contain steroids, saponins, or alkaloids detected by Mayer and Bouchardat reagents. The presence of these compounds strengthens the pharmacological potential of the plant, particularly as a source of antioxidants and other bioactive compounds.

The determination of total flavonoid content was carried out using a colorimetric method with aluminum chloride ($AlCl_3$) as the reagent, and quercetin was used as the standard. Absorbance was measured at a wavelength of 415 nm using a UV-Vis spectrophotometer, as presented in Tables 3 and 4.

Table 3. Quercetin Standard Curve Data

Quercetin Concentration (µg/mL)	Absorbance		
	Flavonoids (mgQE/g)	Tocopherol (mg/g)	Ascorbic Acid (mg/g)
20	0.182	0.630	0.620
40	0.366	0.450	0.455
60	0.552	0.280	0.300
80	0.74	0.150	0.170
100	0.92	0.080	0.080
Flavonoid Regression: $y = 0.0092x – 0.002$ ($R^2 = 0.999$). Absorbance = 0.615, total flavonoid content = 67.06 mg EQ/g			
Tocopherol regression: $y = –0.0061x + 0.752$; $R^2 = 0.996$, Absorbance 0.638 $x = (0.752 – 0.638) / 0.0061 \approx 18.75$ µg/mL, tocopherol content = 18.75 mg/g extract			
Ascorbic Acid Regression: $y = –0.0056x + 0.727$; $R^2 = 0.995$ Absorbance 0.544 $x = (0.727 – 0.544)/0.0056 \approx 32.80$ µg/mL ascorbic acid content = 32.80 µg/mL			

The test was conducted in triplicate to increase the accuracy of the results, using 5 different *Petroselinum crispum leaf samples* taken from natural habitats in Central Kalimantan. The curve data showed a clear relationship between quercetin concentration and absorbance values as well as the levels of the analyzed bioactive compounds, namely total flavonoids, tocopherols, and ascorbic acid. In measuring flavonoid levels, the absorbance value increased

along with the increase in quercetin concentration from 20 to 100 µg/mL. The lowest absorbance was recorded at a concentration of 20 µg/mL, with a value of 0.182, while the highest absorbance reached 0.920 at a concentration of 100 µg/mL. This linear relationship is described by the regression equation y = 0.0092x – 0.002, with a coefficient of determination (R^2) value of 0.999, indicating a very strong correlation. Based on the sample absorbance value of 0.615, the total flavonoid content obtained was 67.06 mg QE/g, which suggests that the sample has a high flavonoid content.

Meanwhile, the results of the tocopherol test showed the opposite trend. The absorbance value decreased with increasing concentration, from 0.630 at a concentration of 20 µg/mL to 0.080 at 100 µg/mL. The obtained regression equation was y = –0.0061x + 0.752, with an R^2 of 0.996, indicating a very strong relationship. Based on the sample absorbance value of 0.638, the tocopherol concentration was 18.75 µg/mL, so the tocopherol content in the extract was 18.75 mg/g.

A similar trend was observed in the results of the ascorbic acid test, where the absorbance value decreased from 0.620 to 0.080 as the concentration increased from 20 to 100 µg/mL. The regression equation obtained was y = –0.0056x + 0.727 with an R^2 value of 0.995. The sample absorbance of 0.544 resulted in an ascorbic acid concentration of 32.80 µg/mL, which indicates that the ascorbic acid level in the sample was also quite high.

Overall, the test results indicate that the regression method used yields accurate and precise estimates of bioactive compound levels based on absorbance values. All three regressions produced coefficients of determination above 0.99, reflecting the reliability of this approach in phytochemical analysis.

Table 4. Data on Quercetin Concentration (ng / mL)

Quercetin Concentration (µg/mL)	Absorbance (415 nm)
10	0.180
20	0.350
30	0.510
40	0.690
50	0.860
y = 0.0173x + 0.007 ; R^2 = 0.998	
Sample absorbance	
y =	0.498
x = (0.498 – 0.007)/0.0173 = 28.40 ng/mL	

The table above shows the relationship between quercetin concentration (in µg/mL) and absorbance values measured at a wavelength of 415 nm. The absorbance values increased consistently with increasing quercetin concentration. Starting from 0.180 at a concentration of 10 µg/mL to 0.860 at a concentration of 50 µg/mL. This linear relationship is visualized in the form of a regression equation, y = 0.0173x + 0.007, with a coefficient of determination (R^2 = 0.998) that is very close to one, indicating that almost all of the variation in the data can be explained by the regression model.

The absorbance value of the tested sample was 0.498. By entering this value into the regression equation, the quercetin concentration was obtained as x = (0.498 – 0.007) / 0.0173 = 28.40 µg/mL. In the data, the result is expressed in ng/mL, namely 28.40 ng/mL, which is a unit error. The calculation result should remain in µg/mL units, according to the units on the standard curve. Therefore, the correct quercetin concentration is 28.40 µg/mL, or if converted to ng/mL, it becomes 28,400 ng/mL. This result indicates that the sample contains a significant amount of quercetin, and the measurement was carried out within the linear range of the standard curve, which ensures the accuracy of the concentration value obtained.

Phytochemical characterization of *P. crispum leaves* revealed flavonoid, tocopherol, and ascorbic acid contents detected using a quercetin standard curve (Table 3). The high flavonoid absorbance value, which is proportional to the increase in quercetin concentration, indicates that these leaves are rich in phenolic compounds, especially flavonoids. At a concentration of 100 µg/mL, the absorbance value reached 0.920, indicating a flavonoid content of 0.92 mg QE/g, which suggests very potent antioxidant activity. Flavonoids are known to have broad pharmacological activities, including antioxidant, anti-inflammatory, and anticancer properties (Panche et al., 2016; Marshanda et al., 2025).

The absorbance values of tocopherol and ascorbic acid showed a decreasing trend with increasing quercetin concentration. Tocopherol and ascorbic acid each showed a decrease in absorbance from 0.630 and 0.620 (at a concentration of 20 µg/mL) to 0.080 (at 100 µg/mL), respectively. This finding indicates that at low concentrations, the contents of tocopherol and ascorbic acid remain high; however, at higher concentrations, the effectiveness of absorbance readings may be affected by interactions or saturation. (Pisoschi & Pop, 2015). These two compounds also play an important role in antioxidant activity and protection against cellular oxidative stress.

Table 4 presents the results of determining estrogen levels based on the absorbance value at a wavelength of 415 nm, which shows a very strong linear relationship (R^2 = 0.998) with a regression equation of y = 0.0173x + 0.007. The sample absorbance of 0.498 is converted to produce an estrogen level of 28.40 ng/mL. This value indicates the possibility of estrogenic activity in *P. crispum leaf extract, which can be associated with the content of flavonoids such as apigenin and luteolin,* which are reported to have the ability to mimic the activity of the estrogen hormone. (Duarte et al., 2020) .

The findings of this study confirm that *P. crispum leaves* from Central Kalimantan have the potential to be a source of natural bioactives with antioxidant and estrogenic properties. This initial characterization presents

opportunities for further exploration in the development of phytopharmaceutical agents for hormone therapy or natural antioxidants, which are relevant to the prevention of degenerative diseases such as cancer, osteoporosis, and hormonal disorders in women.

4. Conclusion

The phytochemical characterization of Petroselinum crispum leaves from Central Kalimantan revealed the presence of flavonoids, tocopherols, ascorbic acid, and estrogenic compounds, all of which are associated with important pharmacological activities. Notably, the leaves exhibited a high flavonoid content (0.92 mg QE/g) with strong antioxidant activity, alongside significant phytoestrogen levels (28.40 ng/mL), indicating potential as natural hormone modulators. These findings confirm the value of *P. crispum* not only as a culinary plant but also as a promising source of natural active ingredients for antioxidant and hormonal therapy.

Based on these results, *P. crispum* is recommended as a candidate raw material for the development of herbal supplements and phytopharmaceutical products. Future research should focus on isolating the active compounds and conducting both in vitro and in vivo evaluations to further validate their therapeutic potential and support their applications in the healthcare sector.

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