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Phytochemical study and pharmacological activity of the schoutenia ovata korth. stems from the hills of Tulungagung

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ABSTRACT

Schoutenia ovata Korth. has a shrub or tree habit and is able to grow up to a height of 25 meters. Humans often use this plant as medicine, one of which is found on the stems. However, no one has researched the good phytochemical content of this plant stem. This is evident in the PubChem data, which indicates that there is no phytochemical profile available for this plant. Therefore, this study aims to determine the phytochemical content and pharmacological activity of Schoutenia ovata Korth. stems. The sample in this study is a stem taken from the hills of Tulungagung, East Java, Indonesia. The sample is then dried and made into a coarse powder. The content of chemical elements is analyzed using an X-ray fluorescence spectrometer. Furthermore, phytochemical tests are conducted to identify the presence of flavonoids, alkaloids, steroids, tannins, saponins, and phenols using the LC-MS/MS QTOF method. Pharmacological activities are investigated through a literature study. The Schoutenia ovata Korth. stems contain chemical elements O (48.6%), C (47%), K (2.9%), Ca (0.6%), Al (0.2%), Si (0.2%), P (0.2%), Cl (0.2%), Mg (0.1%). The results of phytochemical tests show that the stem contains alkaloids, flavonoids, and steroids. Based on the content of phytochemical compounds, the stems of Schoutenia ovata Korth. exhibits pharmacological activities, including antidiabetic, analgesic, anti-inflammatory, antioxidant, immunomodulatory, anticancer, and wound-healing properties.

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INTRODUCTION

The population of *Schoutenia ovata* Korth. in the hills of Tulungagung is decreasing, despite the *Schoutenia ovata* Korth. being one of the characteristic and locally valued plants in Tulungagung. This is feared because knowledge of the benefits of *Schoutenia ovata* Korth. has become extinct. Therefore, it preserves *Schoutenia ovata* Korth. is an effort that must be made immediately to maintain the sustainability of traditional medicinal ingredients, protect local wisdom, and ensure the sustainability of national bioprospecting. Without the preservation of this plant, the potential

for scientific knowledge about the benefits and culture of this plant will be lost. Previous studies have demonstrated that the *Schoutenia ovata* Korth. has numerous applications in local wisdom across several regions in Southeast Asia, particularly in Indonesia (Palupi et al., 2021). Here are some aspects of local wisdom related to the *Schoutenia ovata Korth.*: *First*, it is a natural pesticide. One of the most well-known uses of the *Schoutenia ovata* Korth. is as a natural pesticide. Local people have long used this plant to make pesticide solutions that control pests on crops. *Second*, as a fish poison. The local community uses a mixture of *Schoutenia ovata* Korth. extract and water to drive fish out of the water, making them easier to catch. *Third,* as traditional medicine. *Schoutenia ovata* Korth. is used in traditional medicine in some local communities. Some of the medical conditions treated using this plant include stomach pain, canker sores, and indigestion. *Fourth*, as a natural dye. Some local communities use *Schoutenia ovata* Korth. root as a natural source of dye for textiles and fabrics.

Setyorini has researched the ethnobotanical study of *Schoutenia ovata* Korth. and their morphology (Setiyorini & Setyowati, 2022). In Setyorini's research, it is shown that the stems of the *Schoutenia ovata* Korth. has been used by the community for various crafts and as an herbal medicine. However, Setyorini's research has not examined the chemical content of the *Schoutenia ovata* Korth. stems. Research related to phytochemistry and pharmacological potential of *Schoutenia ovata Korth.* is still minimal (Palupi et al., 2021). Based on the description above, the results of previous research related to *Schoutenia ovata* Korth. are still limited. The data in PubChem also does not have a phytochemical profile of the guardian plant. Meanwhile, research conducted by Setyorini shows that many people use the stems of the *Schoutenia ovata* Korth. as herbal medicine, namely to treat diarrhoea and fever. The stems of the *Schoutenia ovata* Korth. may contain various phytochemical compounds that can be used as medicines. By knowing its chemical content, it will be possible to know its pharmacological activity.

Some previous studies on phytochemical content and pharmacological activity have been widely conducted, but on other plants. Previous research results show that turmeric exhibits pharmacological activity as an anticancer, antimicrobial, anti-inflammatory, antioxidant, antidiabetic, and anti-Alzheimer's agent (Mohsin et al., 2020; Sohn et al., 2021). Curcumin is a polyphenol that exhibits a wide range of pharmacological activities and plays an anticancer role in many types of cancer cells. Curcumin induces HspG2 cell death by increasing apoptosis and pyroptosis, and ROS plays a key role in this process (Liang et al., 2021). Red betel plants contain essential oils (monoterpenes, secuiterpenes), alkaloids, flavonoids (aurone group), tannin-polyphenols, steroids, and neoligament compounds. At the same time, pharmacological tests have shown that this plant exhibits anti-inflammatory, antimicrobial, antifungal, antihyperglycemic, antiproliferative, and antioxidant activity (Parfati & Windono, 2016).

Aspergillus endophytic mushrooms contain butenolides, alkaloids, terpenoids, cytochalasins, phenalenones, r-terphenyls, xanthones, sterols, diphenyl ethers, and anthraquinone derivatives with a wide range of biological activities, such as anticancer, antifungal, antibacterial, antiviral, anti-inflammatory, antitrypanosomal, and antileishmanial activities (El-Hawary et al., 2020). Cactus extract contains phenolic acids and flavonoids (Taleb et al., 2022). *Murraya koenigii* showed the highest phenol and alkaloid content (1960.71±66.88 mg/g and 19.42±0.26 mg/g). *Enicostemma axillare* shows the highest content of flavonoids and tannins (22.27±0.86 and 1.26±0.017). Therefore, *E. axillare* and *M. koenigii* can be used as nutraceuticals in traditional medicine (Rajkumar et al., 2022). *Ocimum sanctum* ethanol extract contains phytochemical compounds, including flavonoids, phenols, tannins, saponins, alkaloids, steroids, and terpenoids (Kustiati et al., 2022).

Some of these previous studies can serve as a reference for research on the chemical content and pharmacological activity of the *Schoutenia ovata* Korth. stemz, particularly in terms of its testing methods. The novelty of this study is to enrich the data on phytochemical content and pharmacological activity, especially on *Schoutenia ovata* Korth. stems from the hills in

Tulungagung, which currently does not exist. In addition, this study may reveal the presence of new bioactive metabolites and pharmacological activity in the stems of *Schoutenia ovata* Korth., which, in previous studies, focused more on the properties of wood and the application of materials such as fibers for construction. This study examined local plants in the hills of Tulungagung, which made it possible to find local chemotypes or endemic compounds. Although there has been research on *Schoutenia ovata* Korth. In the hills of Tulungagung, but only in its morphology and ethnobobotany. Therefore, it is necessary to research and test the content of phytochemical compounds from the stems of the *Schoutenia ovata* Korth. and its pharmacological activity.

RESEARCH METHOD

Tools and Materials

The tools used in this study include scales, blenders, maceration tubes, ovens, micro pipettes, rotary evaporators, water baths, micro tips, ice boxes, microplate readers, and other laboratory equipment. The material is the *Schoutenia ovata* Korth. stems, taken from the hills of, Tulungagung, East Java.

Preparation of Simplicia

The stems are cleaned and then cut into small pieces, dried in the sun until completely dry. After that, the stems pieces are blended into a powder and extracted.

Testing of the Content of Chemical Elements and Phytochemical Compounds

The content of the chemical elements is tested with an X-Ray Fluorescence spectrometer. For phytochemical testing, samples were macerated for 72 hours using a 96% ethanol solvent. Then phytochemical tests were carried out to determine the presence of flavonoids, alkaloids, steroids, tannins, saponins, and phenols using LC-MS/MS Quadrupole Time-of-Flight (QTOF) screening. QTOF screening is an analytical method that utilizes a QTOF instrument to identify chemical compounds present in a sample. To strengthen the test results, a literature review was also conducted on its pharmacological activity.

RESULTS AND DISCUSSIONS

Chemical Element Profile of the Schoutenia ovata Korth. Stems

Chemical Element Profile of the *Schoutenia ovata* Korth. stems as presented in Figure 1.

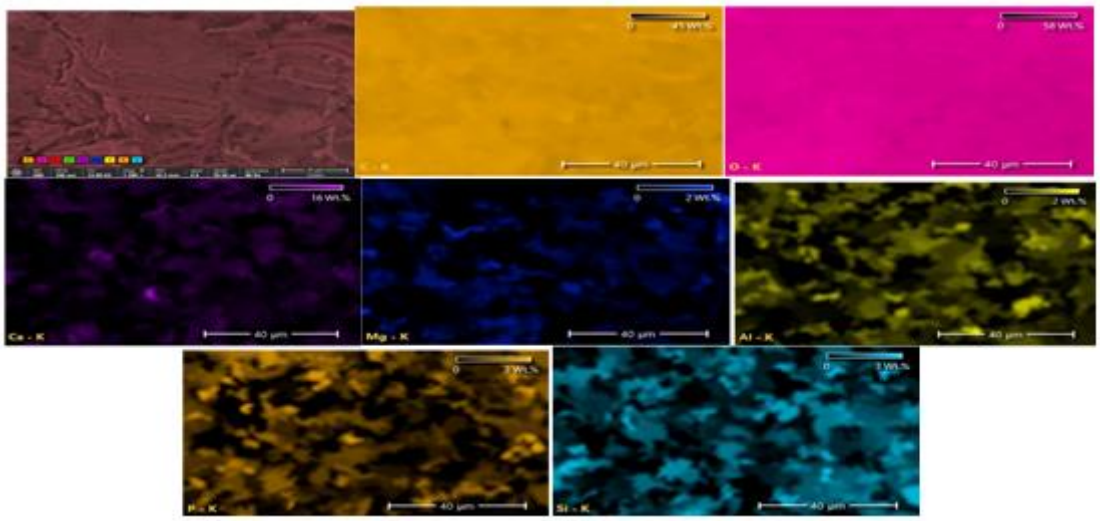

Figure 1. The profile of the *schoutenia ovata* korth. stems

The image above is from an electron microscope, taken in CBS (likely "compositional backscattered electron") detection mode, with an element analysis overlay using EDS (Energy Dispersive X-ray Spectroscopy). Total number of counts: 319 930, average count rate: 1 188 cps, acceleration voltage: 12 kV, total acquisition time: 300 seconds, and maps resolution: 768 x 512. The image shows the surface of the sample at the micrometre scale, allowing fine structures and small particles to be clearly visible. In the image, it can be seen that the uneven distribution of elements on the surface may indicate the presence of prominent fibres or structures, which could be organic residues, minerals, or contaminants. The composition of the detected elements (C, O, K, Ca, Cl, P, Al, Si, and Mg) can provide insight into the material's origin or the chemical processes that occur on its surface.

Table 1. The chemical element content of *schoutenia ovata* korth. stems

Element	Atomic %	Atomic % Error	Weight %	Weight % Error	Net Counts
Si	0.2	0.0	0.4	0.0	1 329
C	47.0	0.2	37.4	0.2	118 083
O	48.6	0.3	51.5	0.3	66 032
Mg	0.1	0.0	0.1	0.0	334
Al	0.2	0.0	0.3	0.0	931
P	0.2	0.0	0.4	0.1	1 029
Cl	0.2	0.0	0.5	0.0	1 093
K	2.9	0.1	7.6	0.2	11 636
Ca	0.6	0.0	1.7	0.1	2 170

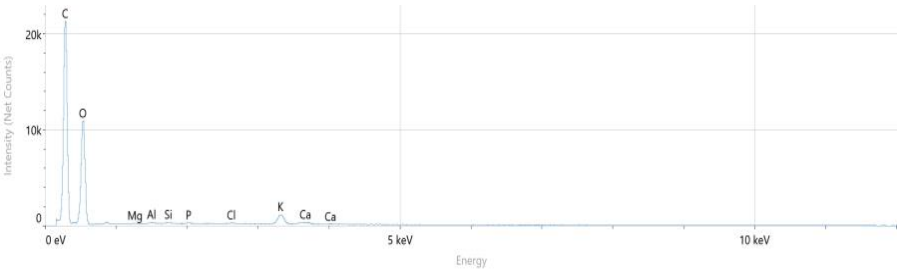

Figure 2. Graph of the chemical elements of the *schoutenia ovata* korth. stems

Based on the test results, the stems of *Schoutenia ovata* Korth. contained the chemical elements O (48.6%), C (47%), K (2.9%), Ca (0.6%), Al (0.2%), Si (0.2%), P (0.2%), Cl (0.2%), Mg (0.1%), and the highest element was oxygen (48.6%), then carbon (47%), and the lowest Mg was 0.1%. The primary chemical components found in *Schoutenia ovata* Korth. stems are oxygen (O) at 48.6% and carbon (C) at 47%. These stems are mostly made of organic molecules, such as lignin, cellulose, and other carbon-based substances, which serve as the foundation for plant cell structure, as shown by the high oxygen and carbon contents (Y. Wang et al., 2022). Secondary metabolites, which function as bioactive substances like flavonoids and alkaloids that have been demonstrated to have broad pharmacological activity, are formed primarily by carbon and oxygen elements.

Additionally, the 2.9% potassium (K) and 0.6% calcium (Ca) contents show how important these minerals are for plant metabolism and the synthesis and operation of bioactive chemicals. While calcium serves as an enzyme cofactor and in cellular communication processes that can impact the biosynthesis of secondary metabolites, potassium is known to be involved in the regulation of osmosis, nutrient transport, and enzymatic activity (Alrashidi et al., 2022; Sardans & Peñuelas, 2021). The content of other elements, such as aluminum (Al), silicon (Si), phosphorus (P), chlorine (Cl), and magnesium (Mg), despite their small presence (0.1%-0.2%), is an important element that contributes to the structural stability and chemical activity of plants. Phosphorus, for example, is vital for energy transfer in the form of ATP and membrane phospholipid metabolism

(Alrashidi et al., 2022). Magnesium, as the molecular center of chlorophyll, plays a crucial role in photosynthesis and also serves as a cofactor for various enzymes involved in the manufacture of bioactive metabolites. The content of these elements indicates a complex and diverse chemical composition, which can contribute to the therapeutic nature of their biological activity.

The Phytochemical Content of The *Schoutenia ovata* Korth. Stems.

The phtytochemical content of the *Schoutenia ovata* Korth. stems as presented in Table 2.

Table 2. The phytochemical content of the *schoutenia ovata* korth. stems

Phytochemical Compounds	Component	Result
Alkaloid	Nigeglapine	Positive
Flavonoid	Bilobetin	Positive
Tannin	-	Negative
Saponin	-	Negative
Steroid	Cynanoside M	Positive
Phenol	-	Negative

Based on the results of testing the phytochemical content of the *Schoutenia ovata* Korth. stems, it was found that the *Schoutenia ovata* Korth. stems contain alkaloids with a nigeglapine component, flavonoids with a bilobetin component, and steroids with cynanoside M content. These three groups of compounds play a crucial role in the biological and pharmacological activities of plants, providing a scientific basis for the therapeutic potential of these plants.

Alkaloids are known to have antidiabetic activity, with the ability to lower blood sugar levels and improve glucose metabolism, while also acting as analgesics and anti-inflammatories. Alkaloids in the stems of *Schoutenia ovata* Korth. may have an inhibitory effect on enzymes related to diabetes, as well as improve nervous system function. The component found in alkaloids is nicotine. Nigeglapine is an organic compound that contains nitrogen and usually has strong biological activity. Nigeglapine, like other alkaloids, exhibits a wide range of potential biological activities, including antioxidant and anti-inflammatory properties (Mollazadeh & Hosseinzadeh, 2014). Nigeglapine also exhibits strong antibacterial, antifungal, and antiviral properties, and is effective against drug-resistant bacteria such as MRSA and various oral pathogens (Abbas et al., 2024).

Nigeglapine also has the potential to be an anticancer by inducing apoptosis and inhibiting cancer cell proliferation (Shafiq et al., 2014); it helps manage hypertension, hyperlipidemia, and atherosclerosis through its antioxidant and anti-inflammatory effects (Shakeri et al., 2018); it has hypoglycemic properties that help control blood sugar levels (Alu'datt et al., 2024). In addition, it also acts as a bronchodilator, making it useful in treating asthma and other respiratory conditions (Hwang et al., 2021); protects the digestive tract from ulcers and other disorders (Dalli et al., 2022); and improves the immune response and helps in managing allergic and immunological disorders (Gholamnezhad et al., 2022). The presence of this nigeglapine suggests that Schoutenia ovata stems can have significant pharmacological effects, particularly in regulating metabolism and relieving pain. Alkaloids with nigeglapine components are heterocyclic compounds that are commonly found in various medicinal plants and have a variety of pharmacological activities, such as analgesics, antimicrobials, and antidiabetics.

Flavonoids have powerful antioxidant activity, helping to protect cells from oxidative damage that is usually elevated in patients with diabetes and chronic inflammatory conditions. In addition, flavonoids can enhance insulin sensitivity and reduce tissue inflammation, thereby improving the function of vital organs, such as the kidneys and liver, which are often affected by diabetes. The component found in flavonoids is bilobetin. Bilobetin is a biflavonoid isolated from the leaves of *Ginkgo biloba* (Feng et al., 2020; Ki Lee et al., 2023). Bilobetin exhibits significant antioxidant properties, which help reduce oxidative stress (Feng et al., 2020). It also exhibits anticancer effects, particularly on human hepatocellular carcinoma (HCC) cell lines, by inducing

apoptosis and DNA damage through the increased production of reactive oxygen species (ROS) and the inhibition of CYP2J2 (Ki Lee et al., 2023). Bilobetin also exhibits antibacterial and antifungal activity, although specific research is limited.

Additionally, it has anti-inflammatory properties, which contribute to its therapeutic potential in various inflammatory conditions. Bilobetin also improves osteoblast differentiation, suggesting potential benefits in bone health (Feng et al., 2020). Despite having beneficial effects, bilobetin is reported to have the potential to cause toxicity to the liver and kidneys. Studies in mice show that high doses can cause kidney damage, including vacuolar degeneration and glomerular atrophy (Feng et al., 2020; Q. Wang et al., 2019). Flavonoids with bilobetin content are polyphenol compounds that are known to have strong antioxidant, anti-inflammatory, and neuroprotective activity. Bilobetin, which is the glucuronide of apigenin, is often studied for its ability to protect cells from oxidative stress and inflammation. This supports the potential of this plant in increasing immunity and improving organ function.

Steroids, especially triterpenoid steroids often found in plants, act as immunomodulators and anti-inflammatories, while also helping to improve wound healing and tissue regeneration. This effect is crucial in overcoming diabetes complications, such as wounds that are difficult to heal. The component found in steroids is Cyanoside M. Cynanoside M was identified as part of a broader category of steroid glycosides, known for their potential pharmacological activity. These compounds have been characterised using spectroscopic analysis and chemical evidence (Bai et al., 2005). *Cynanoside M* exhibits a wide range of activities, demonstrating antibacterial, antifungal, antileishmanial, antioxidant, hepatoprotective, antidiabetic, anti-inflammatory, and anticancer effects (Bouyahya et al., 2023). Cynanoside M also exhibits significant anti-inflammatory and immunosuppressive activity (Zhang et al., 2016). Steroids containing cynanoside M are glycoside steroid compounds that are also found in some medicinal plants and have immunomodulatory, anticancer, and wound healing activities. Cynanoside M has the potential to aid in the process of tissue regeneration and provide a therapeutic effect in accelerating wound healing, which is particularly relevant to the medicinal applications of this plant.

The combination of these three compounds in the stems of *Schoutenia ovata* Korth. provides an overview of the multifunctional potential of this plant in the context of modern pharmacology, including antidiabetic, antiviral, anti-inflammatory, immunomodulatory, and protective effects against oxidative damage. This discovery strengthens the scientific foundation for the development of the *Schoutenia ovata* Korth. as an effective source of herbal medicine. Based on its chemical composition and bioactive compounds, the stems of *Schoutenia ovata* Korth. has the potential to exhibit various pharmacological activities, including antidiabetic, analgesic, anti-inflammatory, antioxidant, immunomodulatory, anticancer, and wound-healing properties. This potential opens up opportunities for the development of herbal medicinal raw materials from the stems *of Schoutenia ovata* Korth., which can support the therapy of various metabolic and inflammatory diseases.

CONCLUSION

The stems of *Schoutenia ovata* Korth. contain the main chemical elements in the form of oxygen (O) of 48.6% and carbon (C) of 47%, with potassium (K) of 2.9% and calcium (Ca) of 0.6%. The content of this element indicates that the structure of the stems are mostly composed of organic molecules such as lignin and cellulose which form the basis for the formation of secondary metabolites to function as bioactive compounds. Other elements such as aluminum, silicon, phosphorus, chlorine, and magnesium, although in small amounts, also contribute important to the stability of plant structures and chemical activity.

Phytochemical analysis revealed the presence of alkaloids with the component of nigeglapine, flavonoids with bilobetin, as well as steroids with cynanoside M in the stems of this plant. These three types of compounds play a significant role in the pharmacological activity of

plants, including antidiabetic, anti-inflammatory, antioxidant, immunomodulatory, anticancer, and accelerating wound healing. Nigeglapine alkaloids have various bioactive effects such as antibacterial, antiviral, and anticancer; The flavonoid bilobetin is known to be powerful in reducing oxidative and inflammatory stress; while cynanoside M steroids contribute to immune modulation and tissue repair.

The combination of chemical elements and phytochemical compounds provides a strong scientific basis regarding the therapeutic potential of *Schoutenia ovata* Korth. stems as a multifunctional source of herbal medicine, opening up opportunities for the development of pharmaceutical ingredients and modern therapies for various metabolic and inflammatory diseases. The findings of the phytochemical content and pharmacological activity of Schoutenia ovata Korth. from Tulungagung not only enriches Indonesia's natural medicine biodiversity database, but also provides a strong alternative for the development of phytopharmaceuticals, local bioactive-based industrial innovations, and the independence of national drug raw material providers. This research also contributes to the preservation of local wisdom, scientific findings of the use of traditional medicine from Schoutenia ovata Korth., strengthens cultural and economic value, and encourages sustainable conservation.

As a practical recommendation for further research, it can be carried out an in vivo test research on experimental animals, toxicity studies, pharmacokinetics, and GCP-based clinical trials, as an effort to ensure its safety and effectiveness, which can then be developed into Indonesia's biodiversity-based national phytopharmaceutical.

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