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Review Article

Phytochemical and Pharmacological Activities of *Curcuma purpurascens* Blume, A Review

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ABSTRACT
Curcuma sp. is generally used for medicine, starch sources, preservatives, dyes and cosmetics. The use of *Curcuma* spp. for medical has increased because there have been many studies related to its active ingredients, such as flavonoids, essential oils, tannins, quinones, and terpenoids, as well as pharmacological activities, including wound healing, antioxidants, antifungal, anticancer, gastroprotective, and hepatoprotective. *Curcuma purpurascens* Blume is a species of *Curcuma* from family Zingiberaceae and used for traditional medicine. This article focuses on reviewing the literatures on *C. purpurascens* and discussing its morphology, phytochemical content, and pharmacological aspects. The method used to review this article was by exploring several databases such as Scopus, Pub Med, and Google Scholar to identify and download original articles and research journals related to the morphology, phytochemical content, and biological activity of *Curcuma purpurascens* Blume. The result of this review will later provide information about the uses and presence of *Curcuma purpurascens* Blume which is still rarely studied so further study related to its pharmacological activity tests and active compound as natural medicines can be explored.

INTRODUCTION
The genus Curcuma is a member of the Zingiberaceae family which is widely distributed and thrives in tropical and sub-tropical areas in Asia, Africa and Australia, and it has more than 93 species (Sasikumar 2005; Ayati et al. 2019). *Curcuma* is rich in medicinal properties, nutritional content and has a high economic value or used as an ornamental plant (Charon 2006; Li 2011; Rajkumari & Sanatombi 2018). Phytochemical content of the genus *Curcuma* includes phenolic compounds, diarylpentanoids (Sihanat et al. 2020), and essential oils (Hong et al. 2014), as well as curcumin (Li 2011; Ayati et al. 2019). The rhizome of *Curcuma* is commonly used as spices, herb, preservative, food flavoring, cosmetics, and a source of yellow dye for coloring agents as well as a source of starch. This part of the plant can cure various diseases such as

urinary tract infections, liver disease, chickenpox, wound healing, rheumatoid arthritis, cancer and digestive disorders. Also, it can reduce abdominal pain and minimize menstrual pain (Al-Reza et al. 2010; Xiang et al. 2011; Mahalakshmi et al. 2019).

The position of the inflorescences, the color of the rhizome and flowers, the shape of the protective leaves, as well as the flower parts are the primary determining characteristics of the species (Skornickova et al. 2007). The flowers have a variety of colors and blades of leaves tapering to the petiole (Larsen & Larsen 2006; Saensouk et al. 2015). *Curcuma* is an edible plant that can be eaten either raw or cooked as a vegetable (Larsen et al. 2000; Charon 2006; Saensouk et al. 2015).

Naturally and traditionally, *Curcuma* plant is used for treatment such as wound healing, gastric ulcers (Mishra et al. 2018), rheumatism, chest pain, ulcers, liver and spleen disorders, diabetes, cough, skin diseases and to clean the blood (Abas et al. 2005; Saikia & Borthakur 2010; Devi et al. 2014; Rana et al. 2015; Rajkumari & Sanatombi 2018).

Several studies have been conducted on the pharmacological activity of *Curcuma* (Rouhollahi 2016). *Curcuma* species plants such as *Curcuma xanthorizae*, *Curcuma aeroginosa*, *Curcuma soloensis*, *Curcuma domestica*, *Curuma amada*, *Curcuma aromatica* have several biological activities including antidiabetic, anticancer, antiviral, antifungal, anti-inflammatory, antihepatotoxic, gastroprotective, antiproliferative, antimicrobial, antirheumatic, hypochromatic, antifibrotic , antivenomous, antinociceptive (Srivastava et al. 2006; Policegoudra et al. 2010; Padalia et al. 2014; Jeon et al. 2015; Diastuti et al. 2019).

Several species of *curcuma* have been widely researched regarding pharmacological activity, phytochemical content, utilization of ethnobotany, and isolation of active compounds. However, there are still many species diversity of *Curcuma* which has not been explored, incluiding *Curcuma purpurascens* Blume. Thus we will study the plant morphology, characteristics, phytochemical content and pharmacological activity of *Curcuma puprpurascens* Blume.

GENERAL DESCRIPTION *Curcuma purpurascens* Blume

Curcuma purpurascens Blume is a plant species of *Curcuma* that is still rarely known and studied (Babu et al. 2016). *C. purpurascens* grows as a shurb with regional names, Temu Blenyeh, Temu glenyeh, Temu Tis, Koneng Tinggang with family Zingiberaceae (Chan et al. 2007; Koller 2009; Prasad & Aggarwal 2011; Rouhollahi et al. 2015c; Rouhollahi et al. 2015a). This plant can quickly grow in teak forest reaching 1.75 cm of height and growing branching rhizomes and flowers from October until February, it also grows well in temperatures of 20-30 ˚C (Koller 2009; Hong et al. 2014; Rouhollahi et al. 2015d; Rouhollahi 2016). The rhizome appearance of *C. purpurascens* is almost the same as the rhizome of *C. Longa*. However, it is larger and has a lighter or pale yellow color compared to *C. Longa* (Hong et al. 2014; Rouhollahi 2016). Genetic relationship and chemotaxonomy of *C. purpurascens* and *C. longa* have a similarity index of 75 % (Setyawan 2003).

MORPHOLOGY OF *C. purpurascens*

C. purpurascens has a branched rhizome with a yellow-orange color inside and outside to a whitish tip. It has terminal inflorescences on the leaf axils, the leaves of which are white at the base and predominantly pale green, also slightly pale brown and mottled above. The *C. purpurascens* flower has a white corolla up to 5cm long, a pale creamy yellow labellum measuring about 17 mm x 17 mm, a dark yellow median, pale creamy

Figure 1. Plants and rhizomes of *C. purpurascens* Blume (Photo by OP).

yellow staminodes, and long spurs. The leaves form an elliptical, slightly purple leaf blade along the upper leaf midrib (Koller 2009; Rouhollahi 2016). Rhizome stem of *C. purpurascens* can reach 1 m tall from branching rhizome. Each stem has several leaves with lengths ranging from 19-23 cm and 55-77cm (Rajkumari & Sanatombi 2018). Taxonomy and shape of *C. purpurascens* plants and rhizome can be seen in figure 1.

According to (Rouhollahi 2016), the taxonomy of *C. purpurascens* as follows;

Domain : Eukaryotes
Kingdom : Plants
Division : Fanerogamer
Class : Monocot flowering plants
Family : Zingiberaceae
Genus : Curcuma
Spesies : *Curcuma purpurascens* Blume

PHYTHOCHEMICAL CONTENT OF *C. purpurascens*

A number of studies have been carried out on several plants of the curcuma genus including chemical content, essential oils and pharmacological activities. *C. purpurascens* consists of various secondary metabolites, including essential oils, tannins, alkaloids, flavonoids, and terpenoids (Hong et al. 2014; Rouhollahi 2016). Based on a research by Sinaga et al. (2018), *C. purpurascens* has a group of secondary metabolites including flavonoids, saponins, quinones, and triterpenoids.

The active compounds of *C. purpurascens* have been reported by some research groups including arturmerone, 3,7-cyclodecadien-1-one, c-Elemene, curlone, 3,7-dimethyl-10-(1-methylethylidene), a-Elementone, 6-etheny;-4,5,6,7-tetrahydro-3,6-dimethyl-5-isopropenyl, turmerone, and benzofuran (Rouhollahi et al. 2014; Rouhollahi et al. 2015d; Rouhollahi 2016). As reported Hong et al. (2014) and Hamdi (2015) the largest *C. purpurascens* essential oil content was germacrone, arturmerone, germacrene-B, and curlon. In comparison, research from Hong et al. (2014) reported that the main components of essential oils are turmerone and ar-turmerone, isofurano-germacrene (curzerene) and xanthorrhizol. The rhizome of *C. purpurascens* contains 2-3% essential oil (Setyawan 2003). The volatile oil components identified from *C.purpurascens* are monoterpenoids 9.7%, sesquiterpenes 22.2% and sesquiterpenoids 56.2% (Hong et al. 2014). The monoterpenoid groups found in this study

include thymol, p-cymen-8-o;, 1,8-cineole, camphor, terpinen-4-ol, piperitone, terpineol and borneol, while the sesquiterpenoid group include ar-curcumene, elemen, germacrene-B, elemente, cis-bergamotene, selina-3,7- diene, trans-caryophyllene, elemente, aromadendrene, humulene, trans-farnesene, muurolene, humulene, selinene, bisabolene, sesquiphellandrene, and selinene (Hong et al. 2014; Rajkumari & Sanatombi 2018). On the other hand, the sesquiterpenoid groups identified by Hong et al. (2014) include turmerone, atractylone, curzerene, artumerol, trans-elementone, eudesmole, guaiol, arturmerone, curlone, and germacrone. Meanwhile, Hamdi (2015) in his research succeeded in isolating the active compounds of *C. purpurascens*, namely bisabolane (arturmernone) and one guaine (zedoalactone B) sesquiterpene, curcuminoids curcumin, bisdemethoxycurcumin and demethoxycurcumin. Meanwhile, Rouhollahi et al. (2015d) stated that turmerone is the main compound in *C. purpurascens*.

Apart from the above-mentioned reports, further research should be carried out on the effects of pure compounds, essential oils and fractions on their pharmacological activities. Besides, it is expected to isolate further, characterize and study the active compounds at the molecular level to explore the mechanism of action and pharmacological properties of *C. purpurascens*.

PHARMACOLOGICAL ACTIVITY

The ethnomedicinal of medicinal plants is history of ancient disease treatment which has been widely proven by research with various pharmacological activities (Hajiaghaalipour et al. 2013; Moghadamtousi et al. 2014). *C. purpurascens* is widely used by the community to treat various diseases. People traditionally use it as spices, treatment of boils, scabies, itching, fever, wounds and stomach aches, and externally to reduce fever (Koller 2009; Benzie & Galor 2011; Rouhollahi et al. 2014; Rouhollahi et al. 2015d; Rouhollahi et al. 2015a; Sinaga et al. 2018). In addition, *C. purpurascens* is also used by the community to treat coughs, burns, skin infections, dermatological disorders, and other skin diseases (Koller 2009; Rouhollahi et al. 2014; Rouhollahi et al. 2015a; Hong et al. 2014). To get rid of postpartum dizziness, pregnant women usually mix *C. purpurascens* with *Alyxia stellate* in a poultices formulation (Koller 2009; Rouhollahi et al. 2014).

Studies show that extracts and isolated compounds from the rhizome of *C. purpurascens* Blume have various pharmacological activities. Several activities of *C. purpurascens* have been reported including wound healing, gastroprotective (Rouhollahi et al. 2014; Rouhollahi 2016; Suprihatin et al. 2020), hepatoprotective (Sinaga et al. 2018), and antifungal (Rouhollahi et al. 2015b). Other studies mention that *C. purpurascens* provides anticancer activity (Rouhollahi et al. 2014; Rouhollahi 2016; Suprihatin et al. 2020), angiogenesis (Rouhollahi et al. 2015a), apoptogenic (Rouhollahi et al. 2015d; Hamdi 2015; Rajkumari & Sanatombi 2018; Sinaga et al. 2018), antioxidant (Jalip et al. 2013; Hamdi 2015; Sinaga et al. 2018; Suprihatin et al. 2020) cytotoxicity and antiproliferative (Hong et al. 2014; Rouhollahi et al. 2015e; Suprihatin et al. 2020).

The dichloromethane extract of *C. purpurascens* Blume rhizome has a cytotoxic effect, suppresses the proliferation of HT-29 colon cancer cells and triggers the induction of apoptosis through a mitochondria-dependent pathway with an IC_{50} value of 7.79 ± 0.54 g/mL (Rouhollahi et al. 2015b). The dichlormethane extract fraction of *C. purpurascens* has hepatoprotective activity by reducing the toxic effects of thioacetamide-containing cells, inhibiting cell proliferation, inducing HepG2 cell

apoptosis, and normalizing ROS (Rouhollahi et al. 2015e). The dichlormethane extract of *C. purpurascens* was experimentally able to exert a chemopreventive effect on the development of colon cancer cells by inducing apoptosis, reducing Bcl2 and PCNA and increasing Bax protein expression (Rouhollahi et al. 2015d). A toxicity test conducted by Rouhollahi et al. (2014), showed that *C. purpurascens* is safe to be used as a medicine from natural ingredients.

C. purpurascens Blume rhizome essential oil was reported to be selective as antiproliferative with strong cytotoxicity against HT29 cells with IC_{50} values of 4.9 ± 0.4 g/mL, and weak cytotoxicity against A549 cells, Ca Ski and HCT cells with IC_{50} values respectively of 46.3 ± 0.7; 32.5 ± 1.1, and 35.0 ± 0.3 g/mL, and it did not show any inhibitory effect on MCF7 cells. Meanwhile, the essential oil of *C. purpurascens* rhizome also had mild cytotoxicity against the non-cancerous human lung fibroblast cell line (MRC5), with an IC_{50} value of 25.2 ± 2.7 g/mL (Hong et al. 2014). Research conducted by Hong et al. (2014) stated that *C. purpurascens* essential oil extracted by hydrodistillation had a cytotoxic effect on breast cancer cells.

Based on research from Rouhollahi et al. (2014), hexane extract of *C. purpurascens* rhizome exerts a gastroprotective effect on ethanol-induced gastric ulcers. The gastroprotective effect is achieved by increasing the levels of NO and SOD, so gastric acid can be suppressed - to prevent it damage to the gastric mucosal wall. Hexane extract of *C. purpurascens* also affects wound healing through antioxidant, anti-inflammatory and angiogenesis mechanisms (Rouhollahi et al. 2015a). According to Jalip et al. (2013), antioxidant activity of 98% methanol extract of *C. purpurascens* Blume has a solid category with an IC_{50} value of 36.30 ppm and a flavonoid content of 14.27%. Meanwhile the ethanolic extract of *C. purpurascens* has moderate antioxidant power with an IC_{50} value of 112.93 ppm with a total flavonoid content of 4.77% (Sinaga et al. 2018). Hepatoprotective power of *C. purpurascens* ethanol extract inhibited the increase in GPT and GOT in mice induced by paracetamol (Sinaga et al. 2018). Chloroform and hexane extracts from the rhizome of *C. purpurascens* were reported to have intense inhibitory activity against *Candida albicans* (Vibrianti 2005; Hong et al. 2014). The ethanolic extract of *C. purpurascens* Blume rhizome was reported does not cause toxicity and death in acute and subchronic toxicity tests where the toxic level is 5 or non-toxic according to the Globally Harmonized System of Classification (GHS) classification (Suprihatin et al. 2020). The phytochemical content and pharmacological activity of *C. purpurascens* Blume can be seen in Table 1.

Here in, we documented the existing phytochemistry and pharmacological properties of *C. purpurascens*. The amount of experimental data evidenced vast biological active substance in *C. purpurascens*. It has potential for multiple pharmacological activities such as cancer, wound healing, hepatoprotective, anti-bacteria, anti-inflammatory, antioxidant, which can be explained by the presence of various essential oils, flavonoids, sesquiterpenoids, triterpenoids, steroids, tannins and alkaloids in the herb. Most of the mentioned pharmacological studies have provided some scientific evidence for its traditional medicine in wound healing, fever and anti-bacteria. Therefore, it is vital to conduct future research on the composition and pharmacological significance of the extract.

Wound Healing Activities of *C. purpurascens*

Wound healing is a complex process that restores the morphology and function of damaged tissues. The wound healing process will be deter-

Table 1. Phytochemical content and pharmacological activity *C. purpurascens* Blume.

Extraction	Solvent	Phytochemical content	Activity pharmacology	Empirical use	References
Maceration	Dichloromethane	γ-elemene, a-elemenone, turmerone, curlone and ar -turmerone	Chemopreventive, antioxidants	Itching, scabies, skin infections, boils, coughs, fever, wounds, poultices after childbirth	(Rouhollahi et al. 2015d)
Remaceration	n-hexane. Dichloromethane	c-elemene, a-elemenone, ar-turmerone, turmerone curlone	Anticancer	Fever, coughing sores, boils, hives, scabies	(Rouhollahi et al. 2015b)
Maceration	n-hexane	Sesquiterpenoids, ar-turmerone, turmerone, germacrone	Antioxidants, anti-inflammatory, angiogenesis	Dermatological disorders, wounds, burns, wounds, skin diseases	(Rouhollahi et al. 2015a)
Maceration	n-hexane	Benzofuran, 6-etenil-4,5,6,7-tetrahidro-3,6-dimetil-5-isopropenil, curlone, 3,7-dimethyl-10-(1-methylethylidene) turmerone, c-elemene, 3,7-cyclodecadien-1-one	Gastroprotective	Poultices, wounds, scabies, ulcers, itching, coughing, fever	(Rouhollahi et al. 2014)
Distillation	aqudest	Monoterpenoids; 1,8-cineole, piperiton, borneol, timol, kamper, terpinen-4-ol, p- cymen-8-ol, sesquiterpene; trans-caryophyllene, humulene, δ-elemene, germacrene-B, cis-α-bergamotene, aromadendrene, ar-curcumene, α-terpineol, trans-farnesene, β-- sesquiphellandrene, γ-muurolene, α-Selinene, γ-eudesmol β-bisabolene, selina-3,7(II)-diene, turmerone, curzerene, ar-turmerol, trans-elemenone, germacrone, guaiol, atractylone, ar-turmerone, and curlone	Antiproliferative, antifungal	Skin infection, cough antiproliferative, antifungal	(Hong et al. 2014)
Maceration	Methanol 98%	Flavonoids	Antioxidants	-	(Jalip et al. 2013)
Maceration	Ethanol 96 %	Quinones, triterpenoids, saponins and flavonoids	Antioxidants, hepatoprotector	Ulcers, itching of the skin, abdominal pain, external medicine for fever	(Sinaga et al. 2018)
Distillation	Aquadest	29 components of essential oil components	-	Cosmetics, food coloring and flavoring	(Setyawan 2003)
Maceration	Dichloromethane	-	Hepatoprotector	-	(Rouhollahi et al. 2015e)
Hydrodestilation	Aquadest	Sesquiterpene: guaiane, (zedoalactone) bisabalone (ar-turmerone), curcuminoids: curcumin, bidesmethoxycurcumin, demethoxycurcumin	Antioxidants, cytotoxic, neuroprotective		(Hamdi 2015)
Maceration	Ethanol	Steroids, terpenoids, flavonoids, triterpenoids, and essential oils	Antioxidants, anticancer, toxicity	Skin infections, coughs, and stomach pain	(Suprihatin et al. 2020)
Maceration	Ethanol 96%	Alkaloids, flavanoids, steroids, terpenoids, saponins, and tanins	Antioxidants,	-	(Pramiastuti & Murti 2022)

mined by angiogenesis, collagen synthesis, re-epithelialization and reduction of inflammatory cells (Longo et al. 2011; Rouhollahi et al. 2015a). The inflammatory process in wound healing involves neutrophils and other cells that produce ROS, where if there is excess ROS production, there will be induction of cell apoptosis, one of which is by activating the pro-apoptotic protein Bax (Buemi et al. 2004; Rouhollahi et al. 2015a). Various studies have been conducted on the potential of natural ingredients with anti-inflammatory activity, antibacterial antioxidants and procollagen synthesis as wound healing agents. Its medicinal properties come from the content of bioactive phytochemicals such as essential oils, saponins, alkaloids, tannins, flavonoids and phenolic compounds found in natural products (Ibrahim et al. 2018).

The n-hexane extract of *C. purpurascens* showed wound healing activity after excision in rats topically. Wound healing was evident after administering n-hexane extract of *C. purpurascens* at doses of 100 and 200 mg/kg for 20 days (Rouhollahi et al. 2015a). The number of inflammatory cells in the granulation tissue of mice decreased causing the scar width in mice also to decrease. The content of collagen and fibrotic cells increased after administration of the n-hexane extract of *C. purpurascens* which was characterized by the formation of new blood vessels at the wound site by intracystic cells (Rouhollahi et al. 2015a). The wounding process can also cause an increase in the expression of Hsp 70 protein. Wound healing is also accelerated by a decrease in the induction of Hsp70 protein expression by maintaining protein synthesis and conformation (Lamore et al. 2010; Rouhollahi et al. 2015a). The n-hexane extract of *C. purpurascens* at 100 and 200 mg/kg doses was able to reduce Bax protein expression and induce Hsp70 protein expression (Rouhollahi et al. 2015a).

The wound healing activity also involves the inflammatory process. From the data submitted there are still no research results on anti-inflammatory activity. Adequate studies have not been performed on the inflammatory cells, proinflammatory enzymes (COX and LOX, PLA_2, PGE_2), proinflammatory cytokines and reactive oxygen play a vital part in the pathogenesis inflammation. So it will be interesting to assess its anti-inflammatory effect from pure compounds and fractions of *C. purpurascens*.

Cytotoxic activity of *C. purpurascens*

The cytotoxic activity of *C. purpurascens* rhizomes was assessed against various human cancer cell lines such as MCF7, Ca Ski, A549, HT29, and HCT116 (Rouhollahi et al. 2015a). Essential oil from the rhizome of *C. purpurascens* exerts a strong antiproliferative effect against human carcinoma cells (Hong et al. 2014; Rouhollahi et al. 2015a). The mechanism of essential oils in inhibiting the growth of HT 29 cells are by suppressing COX-2 expression, blocking NF-Pathways B, PI3K/Akt, and ERK1/2 as well as the synergistic effect of other essential oil ingredients such as germacrone, germacrone -B, curlone, turmerone and Ar-turmerone (Hong et al. 2014).

The dichloromethane extract of *C. purpurascens* inhibited the proliferation of HT-29 colon cancer cells by activating the mitochondrial death pathway through the involvement of Bcl-2/Bax/Bcl-xl and ROS production, thereby inhibiting the growth of HT-29 cells. In vivo acute toxicity effect of *C. purpurascens* dichloromethane extracts provides a safe dose of 5 g/kg. The structure of the kidneys and liver remained normal according to histological results after administration of dichloromethane extract at a dose of 2 and 5 g/kg. The antiproliferative

effect of the dichloromethane extract of *C. purpurascens* was assessed by measuring the level of LDH released by HT-29 cells in the MTT assay. After treatment with dichloromethane extract of *C. purpurascens* for 24 hours, HT-29 cells underwent DNA fragmentation and shrinkage, with nuclei turning blue and phalloidin turning red. Administration of dichloromethane extract *C. purpurascens* can increase oxidative stress in HT-29 cells at ROS level in the presence of dihydroethidium oxidation to fluorescent ethidium in DNA due to ROS formation. Dichloromethane extracts *C. Purpurascens* at concentrations between 6.25 and 50 g/ml significantly increased cell membrane permeability and cytochrome c (cyt.c) release (Rouhollahi et al. 2015a). Dichlormethane extract *C. purpurascens* at doses of 250 mg/kg and 500 mg/kg was able to inhibit the formation of aberrant crypt foci (ACF) in azoxymethane-induced mice, followed by a decrease in (Proliferating cell nuclear antigen) PCNA protein expression (Rouhollahi et al. 2015d).

Most of the curcuma species studied had similar chemical components or the same isolates but the pharmacological properties were different and some showed opposite responses. The active constituents and underlying mechanisms responsible for anticancer properties of *C. purpurascens* still need to be discovered, for example studies of its cytotoxic activity against various human cancer cell lines like Hela, Coav-3, HepG2, HL-60 and Hep3B.

Hepatotoxic activity of *C. purpurascens*

The hepatotoxic effect of the ethanolic extract of *C. purpurascens* was tested by measuring the levels of SGOT and SGPT through the presence or absence of liver failure in test animals. The administration of *C. purpurascens* extract to increase SGOT levels in white rats can also be influenced by the number of doses and duration of treatment. An increase in SGPT or SGOT due to changes in permeability or damage to the hepatocyte wall is used as a marker of hepatocellular development (Rosida 2016). If there is an increase in SGOT levels, damaged body cells will be replaced with new cells. The increase in SGPT levels that occurred in the *C. purpurascens* extract was still within normal limits, and was not an indication of impaired liver function (Suprihatin et al. 2020).

Acute toxicity studies revealed that the ethanolic extract of *C. purpurascens* was relatively safe and did not cause symptoms of poisoning or death of animals at a dose of 5000 mg/kg BW. In addition, administration of *C. purpurascens* rhizome ethanol extract at a doses of 1250-5000 mg/Kg BW did not cause qualitative acute toxic symptoms such as changes in skin and hair, behavior, excretory system, respiration, eye injury, and coma and it did not interfere the growth or body weight of the tested animals (Suprihatin et al. 2020). Increased levels of SGPT or SGOT *C. purpurascens* extract had therapeutic potential effect for treatment pf liver dysfunction. However, the above study results were insufficient to draw meaningful conclusions. Therefore, mechanistic and up-to-date studies were needed to understand the hepatotoxic activity better.

Antioxidant activity of *C. purpurascens*

Based on the DPPH test, Temu Blenyeh extract has high antioxidant activity with an antioxidant capacity equivalent to vitamin C (Jalip et al. 2013; Pramiastuti et al. 2021). Antioxidant test conducted by Jalip et al. (2013) showed that the methanol extract of temu blenyeh rhizome had the highest antioxidant activity which was determined by measuring the total of flavonoid content (measured as quercetin) and free radical scav-

enging activity of DPPH. The total of flavonoid content with antioxidant activity of the extract described that the antioxidant activity of the extract might be due, at least in part, to the presence of polyphenols and flavonoids (Nahak & Sahu 2011; Khan 2012; Phuyal et al. 2020). The antioxidant activity of rhizome extract was assessed based on the free radical effect of 1,1-diphenyl-2-picryl-hydrazyl (DPPH) free radical activity (Pal et al. 2011). Antioxidant activity can be an important alternative therapy in preventing and reducing oxidative stress in several diseases including inflammation, cancer and cytotoxicity (Phuyal et al. 2020). Plants with high flavonoid content will have high antioxidant activity which generally has a high therapeutic potential (Sinaga et al. 2018; Widyastuti et al. 2020). The antioxidant potential of *C. purpurascens* needs further research using other methods to study their mechanism of action. Tests for antioxidant activity can use FRAP, TBA, CUPRAC, ABTS, ORAC and others.

Antimicrobial Activity of *C. purpurascens*

Antimicrobial agents are substances that have the ability to inhibit or kill the microbial growth. Many herbal plants can play a role as antimicrobial agents. *C. purpurascens* rhizome extract has antibacterial and antifungal activity. Bacterial growth that can be inhibited by *C. purpurascens* can be in the form of gram-positive bacteria (*Bacillus subtilis* and *Staphylococcus aureus*) and gram-negative bacteria (*Escherichia coli* and *Pseudomonas aeruginosa*). *Candida albicans* is a type of fungus whose growth is inhibited by *C. purpurascens* extract.

The results of fractionation of n-hexane extract showed a minimum inhibitory concentration (MIC) and antibacterial activity against ampicillin of 2508.15 ppm for *Staphylococcus aureus* and 849.37 ppm for *Bacillus subtilis* bacteria. Meanwhile, its antibacterial activity against gram-negative bacteria was 1549.59 ppm for *Escherichia coli*; 2014,65 ppm for *Pseudomonas aeruginosa* (Andriyani & Udin 2006). Thus *C. purpurascens* can be said to have weak antibacterial activity due to the relatively high concentration of extracts that inhibit bacterial growth (Andriyani & Udin 2006). A study conducted by Vibrianti (2005) stated that the extract of *C. purpurascens* can inhibit the growth of the fungus *Candida albicans*, where the extraction using solvents n hexane, ethyl acetate, methanol and water (Vibrianti 2005; Suprihatin et al. 2020).

The inhibition of bacterial growth's production may be influenced by the content of active compounds contained in the rhizome of *C. purpurascens* such as flavonoids, essential oils, alkaloids, terpenoids, and tannins. Flavonoid compounds can damage cell walls and cause cell death (Dermawaty 2015). Tannin compounds can damage the formation of fungal conidia. The content of other compounds such as alkaloids in the rhizome of *C. purpurascens* can denature proteins to damage enzyme activity and cause cell death (Dermawaty 2015). The antibacterial activity of *C. purpurascens* needs to be extensively studied and the mechanisms involved in the antibacterial activity should be further explored.

CONCLUSIONS AND FUTURE PERSPECTIVES

C. purpurascens Blume is one of medicinal plants of the genus *Curcuma* which is used empirically for the treatment of wounds, skin diseases, itching scabies, ulcers and fever. *C. purpurascens* plant has a morphology almost the same as *C. longa* but the shape of the rhizome is larger and light yellow in color. The phytochemical content of *C. purpurascens* includes germacron, turmeron, curcumin, bisabalone, curlone, sesquiterpenes, ar-turmeron, flavonoids, quinones, tannins, terpenoids,

alkaloids and essential oils. These secondary metabolites are able to exhibit pharmacological activities including antioxidants, anticancer, hepatoprotective, gastroprotective, apoptogenic, anti-fungal, antimicrobial, cytotoxis, and anti-proliperative. However, all of these pharmacological activities have only been obtained from the activity of the rhizome extract. Meanwhile, research on essential oils mostly only identified the constituent components and levels of essential oils. *C. purpurascens* has the potential to be explored for pharmacological testing and its active compounds as natural medicine. Thus, a broader and more in-depth research needs to be done to determine its therapeutic potential or pharmacological activity.

AUTHORS CONTRIBUTION

O.P., searched the literatures and wrote the manuscript, S.W., N.F., and P.A. supervised the processes.

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CONFLICT OF INTEREST

There is no conflict interest regarding this research and research funding.

REFERENCES

Abas, F. et al., 2005. A Labdane Diterpene Glucoside from the Rhizomes of Curcuma mangga, *Journal of Natural Products*, 68(7), pp.1090–1093. doi: https://doi.org/10.1021/np0500171.

Al-Reza, S. M. et al., 2010. Essential oil composition and antioxidant activities of Curcuma aromatica Salisb., *Food and Chemical Toxicology*, 48(6), pp.1757–1760. doi: 10.1016/j.fct.2010.04.008.

Andriyani, R. & Udin, L.Z., 2006. Aktivitas Antibakteri Temu Tis, *Prosiding Seminar Nasional, IPTEK Solusi Kemandirian bangsa Dalam Tahun Indonesia untuk Ilmu Pengetahuan, 2006, Agustus 2-3, yogyakarta*, pp.45–53. Available at: http://lipi.go.id/publikasi/aktivitas-antibakteri-temu-tis/10646.

Ayati, Z. et al., 2019. Ethnobotany, Phytochemistry and Traditional Uses of Curcuma spp. and Pharmacological Profile of Two Important Species (C. longa and C. zedoaria): A Review. *Current Pharmaceutical Design*, 25(8), pp.871–935. doi: 10.2174/1381612825666190402163940.

Babu, K.N. et al., 2016. Protocols for In Vitro Propagation , Conservation, Synthetic Seed Production , Microrhizome Production , and Molecular Profi ling in Turmeric *(Curcuma longa* L *.)*. doi: 10.1007/978-1-4939-3332-7.

Benzie, I.F.F. & Galor, W., 2011. *Herbal Medicine: Biomolecular and Clinical Aspects*, 2nd edn., CRC Press/Taylor & Francis. https://pubmed.ncbi.nlm.nih.gov/22593937/

Buemi, M. et al., 2004. Recombinant human erythro_poietin stimulates angiogenesis and healing of ischemic skin wounds. *SHOCK*, 22(2), pp.169–173. doi: 10.1097/01.shk.0000133591.47776.bd

Chan, E.W.C et al., 2007. Antioxidant and antibacterial activity of leaves of Etlingera species (*Zingiberaceae*) in Peninsular Malaysia. *Food Chemistry*, 104(4), pp.1586-1593. doi: 10.1016/j.foodchem.2007.03.023.

Charon, M., 2006. *Taxonomy and phylogeny of the genus curcuma L. (Zingiberaceae) with particular reference to its occurrence in Thailand.* Prince of Songkla University.

Dermawaty, D.E., 2015. Potential Extract Curcuma (*Curcuma xanthorrizal*, Roxb) As Antibacterials. *Medical Journal of Lampung University*, 4(1), pp.5–11.

Devi, N. B., et al., 2014. Ethnomedicinal Utilization of *Zingiberaceae* in the Valley Districts of Manipur. *IOSR Journal of Environmental Science, Toxicology And Food Technology (IOSR-JESTFT)*, 8(2), pp.21–23. doi: 10.9790/2402-08242123

Diastuti, H et al., 2019. Antifungal activity of *Curcuma xanthorrhiza* and *Curcuma soloensis* extracts and fractions. *IOP Conference Series: Materials Science and Engineering*, 509, pp. 1–5. doi: 10.1088/1757-899X/509/1/012047.

Hajiaghaalipour, F. et al., 2013.The Effect of *Camellia sinensis* on Wound Healing Potential in an Animal Model. *Evidence-Based Complementary and Alternative Medicine : eCAM*, 2013, 386734. doi: 10.1155/2013/386734

Hamdi, A.A.O., 2015. *Chemical Constituents From The Rhizomes Of Curcuma zedoria And Curcuma purpurascens and Assessment of Their Biological Activities.* University of Malaya.

Hong, L.-S. et al., 2014. Essential Oil Content of the Rhizome of Curcuma purpurascens Bl . (Temu Tis) and Its Antiproliferative Effect on Selected Human Carcinoma Cell Lines. *The Scientific World Journal*, 2014, 397430. doi: 10.1155/2014/397430.

Ibrahim, N.I. et al., 2018. Review Wound Healing Properties of Selected Natural Products. *International Journal of Environmentsl Research snd Public Health*, 15(2360). doi: 10.3390/ijerph15112360.

Jalip, I.S et al., 2013. Antioxidant Activity and Total Flavonoids Content of Curcuma Rhizome Extract. *The 4th Green Technology Faculty of Science and Technology, Islamic of University State Maulana Malik Ibrahim Malang.*

Jeon, W. et al., 2015. Curcuma aromatica Water Extract Attenuates Ethanol-Induced Gastritis via Enhancement of Antioxidant Status. *Evidence-based complementary and alternative medicine : eCAM*, 2015, 582496. doi: 10.1155/2015/582496.

Khan, R.A., 2012. Evaluation of flavonoids and diverse antioxidant activities of Sonchus arvensis. *Chemistry Central Journal*, 6(1), pp.1–7. doi: 10.1186/1752-153X-6-126.

Koller, E., 2009. *Javanese medicinal plants used in rural communities.* Universität Wien.

Lamore, S.D et al., 2010. The topical antimicrobial zinc pyrithione is a heat shock response inducer that causes DNA damage and PARP-dependent energy crisis in human skin cells. *Cell Stress and Chaperones*, 15, pp.309–322. doi: 10.1007/s12192-009-0145-6.

Larsen, K. et al., 2000. *Gingers of Peninsular Malaysia and Singapore*, Natural History Publications (Borneo), p.135.

Larsen, K. & Larsen, S.S., 2006. Gingers of Thailand, *Queen Sirikit Botanic Garden (QSBG).*

Li, S., 2011. Chemical Composition and Product Quality Control of Turmeric (Curcuma longa L.). *Pharmaceutical Crops*, 5(1), pp.28–54. doi: 10.2174/2210290601102010028.

Longo, G.U. et al., 2011. Tissue engineered biological augmentation fortendon healing: a systematic review. *British Medical Bulletin*, 98, pp.31–59.

Mahalakshmi, S. et al., 2019. Isolation and Pharmacological Activities of Curcumin from Curcuma longa L. *International Journal for Research in Applied Sciences and Biotechnology*, 5(5), pp.7–17. doi: 10.31033/ijrasb.6.5.2

Mishra, R. et al., 2018. Genetic diversity, essential oil composition, and in vitro antioxidant and antimicrobial activity of Curcuma longa L. germplasm collections. *Journal of Applied Research on Medicinal and Aromatic Plants*, 10(June), pp.75–84. doi: 10.1016/j.jarmap.2018.06.003.

Moghadamtousi, S.Z. et al., 2014. A Review on Antibacterial, Antiviral, and Antifungal Activity of Curcumin. *BioMed Research International*, 2014, 186864. doi: 10.1155/2014/186864

Nahak, G. & Sahu, R.K., 2011. Evaluation Of Antioxidant Activity In Ethanolic Extracts Of Five Curcuma Species. *International Journal of Pharmacy*, 2(12), pp. 243–248.

Padalia, R.C. et al., 2014. Volatile terpenoid compositions of leaf and rhizome of Curcuma amada Roxb. from Northern India. *Journal of Essential Oil Research*, 25(1), pp.17–22. doi: 10.1080/10412905.2012.747271.

Pal, J. et al., 2011. Hepatoprotective and antioxidant activity of Zingiber chrysanthum Rosec. rhizomes. *Asian Journal of Traditional Medicines*, 6(6), pp. 242–251.

Phuyal, N. et al., 2020. Total Phenolic, Flavonoid Contents, and Antioxidant Activities of Fruit, Seed, and Bark Extracts of *Zanthoxylum armatum* DC. *Scientific World Journal*, 2020, 8780704. doi: 10.1155/2020/8780704.

Policegoudra, R.S. et al., 2010. Antimicrobial, antioxidant, cytotoxicity and platelet aggregation inhibitory activity of a novel molecule isolated and characterized from mango ginger (*Curcuma amada* Roxb) rhizome. *Journal of biosciences*, 35(2), pp. 231–240. doi: 10.1007/s12038-010-0027-1.

Pramiastuti, O. et al., 2021. Aktivitas Antioksidan Ekstrak Etanol Temu Blenyeh. *Prosiding Seminar Nasional Kesehatan 2021 Lembaga Penelitian dan Pengabdian Masyarakat Universitas Muhammadiyah Pekajangan*, pp.29–37. doi: 10.48144/prosiding.v1i.618

Pramiastuti, O. & Murti, F.K., 2022. Fitokimia dan Aktivitas Antioksidan Ekstrak Temu Blenyeh (*Curcuma purpurascens* Blume). *Jurnal Ilmiah Kesehatan*, 15(1), pp.12–22. doi: 10.48144/jiks.v15i1.627.

Prasad, S. & Aggarwal, B.B., 2011. Turmeric, the Golden Spice: From Traditional Medicine to Modern Medicine. In *Herbal medicine: biomolecular and clinical aspects*. 2nd edition. Boca Raton, FL: CRC Press/Taylor & Francis, Chapter 13. https://www.ncbi.nlm.nih.gov/books/NBK92752/.

Rajkumari, S. & Sanatombi, K., 2018. Nutritional value, phytochemical composition, and biological activities of edible Curcuma species: A review. *International Journal of Food Properties*, 20(3), pp.S2668–S2687. doi: 10.1080/10942912.2017.1387556.

Rana, M. et al., 2015. Turmerone enriched standardized Curcuma longa extract alleviates LPS induced inflammation and cytokine production by regulating TLR4-IRAK1-ROS-MAPK-NFκB axis. *Journal of Functional Foods*, 16, pp.152–163. doi: 10.1016/j.jff.2015.04.034.

Rosida, A., 2016. Pemeriksaan Laboratorium Penyakit Hati. *Berkala Kedokteran*, 12(1), p.123. doi: 10.20527/jbk.v12i1.364.

Rouhollahi, E. et al., 2014. Evaluation of acute toxicity and gastroprotective activity of curcuma purpurascens BI. rhizome against ethanol-induced gastric mucosal injury in rats. *BMC Complementary and Alternative Medicine*, 14, 378, pp.1–10. doi: 10.1186/1472-6882-14-378

Rouhollahi, E. et al., 2015a. Curcuma purpurascens BI. rhizome accelerates rat excisional wound healing: Involvement of Hsp70/Bax proteins, antioxidant defense, and angiogenesis activity. *Drug Design, Development and Therapy*, 9, pp.5805–5813. doi: 10.2147/DDDT.S88196.

Rouhollahi, E. et al., 2015b. Inhibitory effect of Curcuma purpurascens BI. rhizome on HT-29 colon cancer cells through mitochondrial-dependent apoptosis pathway. *BMC Complement Altern Med*, 15, 15. doi: 10.1186/s12906-015-0534-6.

Rouhollahi, E. et al., 2015c. The chemopreventive potential of Curcuma purpurascens rhizome in reducing azoxymethane-induced aberrant crypt foci in rats. *European Journal of Cancer*, 51, e8. doi: 10.1016/j.ejca.2015.06.028.

Rouhollahi, E. et al., 2015d. The chemopreventive potential of Curcuma purpurascens rhizome in reducing azoxymethane-induced aberrant crypt foci in rats. *Drug Design, Development and Therapy*, 9, pp.3911–3922. doi: 10.2147/DDDT.S84560.

Rouhollahi, E. et al., 2015e. Dichloromethane Curcuma purpurascens BI Rhizome Extract Prevents Thioacetamide-Induced Liver Cirrhosis in Rats. in *Conference: 2015 Golden Helix Symposium - Next Generation Pharmacogenomics At: Kuala Lumpur, Malaysia.* Public Health Genomics 18.

Rouhollahi, E., 2016. *Biological Activities Of Curcuma purpurascens Bl Rhizome Extract Using In Vitro and In Vivo Models.* University Of Malaya Kuala Lumpur.

Saensouk, P. et al., 2015. Pollen morphology of the genus Curcuma (Zingiberaceae) in Northeastern Thailand. *Science Asia*, 41(2), pp.87–92. doi: 10.2306/scienceasia1513-1874.2015.41.087.

Saikia, B. & Borthakur, S.K., 2010. Use of medicinal plants in animal healthcare- A case study from Gohpur, Assam. *Indian Journal of Traditional Knowledge*, 9(1), pp.49–51. http://nopr.niscpr.res.in/handle/123456789/7153

Sasikumar, B., 2005. Genetic resources of Curcuma : diversity, characterization and utilization. *Plant Genetic Resources*, 3(2), pp. 230–251. doi: 10.1079/pgr200574.

Setyawan, A.D., 2003. Diversity of essential oils constituent of Curcuma. *Biofarmasi Journal of Natural Product Biochemistry*, 1(2), pp.44–49. doi: 10.13057/biofar/f010202.

Sihanat, A., Theanphong, O. & Rungsihirunrat, K., 2020. Assessment of phylogenetic relationship among twenty Curcuma species in Thailand using amplified fragment length polymorphism marker. *Journal of Advanced Pharmaceutical Technology and Research*, 11(3), pp.134–141. doi: 10.4103/japtr.JAPTR_24_20.

Sinaga, E., Suprihatin & Rastuti, M.R., 2018. Kadar Flavonoid Total, Daya Antioksidan dan Daya Hepatoprotektif Ekstrak Etanol Rimpang Temu Tis (Curcuma purpurascens). *Konggres XX dan Pertemuan Ilmiah Tahunan Ikatan Apoteker Indonesia 2018*, p.13.

Skornickova, J.L. et al., 2007. Chromosome numbers and genome size variation in Indian species of Curcuma (Zingiberaceae). *Annals of Botany*, 100(3), pp.505–526. doi: 10.1093/aob/mcm144.

Srivastava, S. et al., 2006. Pharmacognostic Evaluation of *Curcuma aeurigenosa* Roxb. *Natural Product Sciences*, 12(3), pp.162–165.

Suprihatin, Tambunan, C. & Sinaga, E., 2020. Acute and Subchronic Toxicity Of Temu Tis (Curcuma Purpurascens Bl.) Rhizome in Mouse (Rattus Norvegicus). *Journal of Tropical Biodiversity*, 1(1), pp.47–62.

Vibrianti, Y., 2005. *Isolasi dan Identifikasi Fraksi Aktif Antijamur dalam Rimpang Temu Tis (Curcuma purpurascens Bl.)*. Fakultas Matematika dan Ilmu Pengetahuan Alam, Universitas Sebelas Maret.

Widyastuti, I. et al., 2020. Antioxidant Activity of Temulawak (Curcuma xanthorrhiza Roxb.) and its Classification with Chemometrics. *Indonesian Journal of Chemometrics and Pharmaceutical Analysis*, 1(1), p.29. doi: 10.22146/ijcpa.507.

Xiang, Z. et al., 2011. Metabolomics study on quality control and discrimination of three curcuma species based on gas chromatograph-mass spectrometry. *Phytochemical Analysis*, 22(5), pp.411–418. doi: 10.1002/pca.1296.