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Review Article

A Review of *Etlingera coccinea* (Blume) S. Sakai and Nagam (Zingiberaceae) on Achievement of Producing An Essential Oil and Medicinal Properties in Sabah, East Malaysia.

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ABSTRACT

The wild ginger, Tuhau, *E. coccinea* is a plant species from *Etlingera* genus and *Zingiberaceae* family. This study is focused on a reviewed paper reported on the extraction method used to derive essential oils and the overview of the published data regarding medicinal properties of *Etlingera coccinea* spp. The search was performed in several databases such as *ScienceDirect*, *Scopus*, *SpringerLink*, and *Researchgate* and also Google Scholar. The following keywords were used individually and or in combination "*E. coccinea*" and "Tuhau". This article highlights the extraction techniques used to derive the essential oil of *E. coccinea* and also provide briefly overview of the medicinal properties from the data in recent literature.

Keywords: *Etlingera coccinea;* Tuhau; medicinal properties

Introduction

Sabah is one of the areas where tropical rainforests predominate; these rainforests are well-known among researchers for their vast diversity of flora as well as their special geological, topographical, and climatic circumstances (Deluxe Journeys, 2020). There are up to 4,500 species of flora and fauna; one of these is the wild ginger species, *Etlingera coccinea*.

Etlingera coccinea is a plant species from the *Etlingera* genus and *Zingiberaceae* family (Shahid-Ud-Daula et al. 2015). This plant is distributed throughout Asia to the Pacific islands including Borneo, Peninsular Malaysia, Philippines, Singapore, Sumatra, Thailand and Vietnam (Devanathan & Mustaqim, 2020; Ardiyani & Poulsen, 2019). As described by Poulsen (2006), this species was primarily found in lowland environments, mature primary forest, shaded areas,

secondary logged woods, young or old fields, grazing areas and grazed woodlands, orchards, paddy fields, and also close to streams.

It is locally known as Tuhau and used by the native people of Sabah (Kulip, 2007) and grows to an average of 2 m (Daniel-Jambun et al. 2017), 5-8 m (Devanathan & Mustaqim, 2020) and grows wildly to an average of 40 to 1,650 m elevation (Devanathan & Mustaqim, 2020). As mentioned by Shahid-Ud-Daula & Basher (2019), *Etlingera* sp., grows as clumps of leafy shoots, while others have long creeping rhizomes with each of their leafy shoots being be more than a metre apart.

E. coccinea is known for its distinctive inflorescence, which is highly prized as an ornament. Bright red inflorescences that resemble petals are present on the surface of the ground (see **Figure 1**). Its fruit matures below the ground (see **Figure 2**). This plant has a strong fragrant content because of the high concentration of essential oils in the leaves, stems, flowers, fruits and rhizomes (Jems et al. 2021; Vairappan et al. 2012; Nagappan et al. 2017). We discovered that the colour of the stems can distinguish between two types of *E. coccinea*, the red stems (dark reddish stem) are more pungently scented than white stems. While the scent of white Tuhau (greenish stem) is less pungent than red Tuhau and supported by the results of a survey we conducted among forest rangers in the DaMaI Conservation Areas (Danum Valley, Maliau Basin and Imbak Canyon), Tuhau sellers in the market and consumers who come from various areas such as Ranau, Kadamaian, Kiulu, Tambunan, Tamparuli and Telupid.

Most research on this native ginger species focuses on how it can be used as a spice or as a medicine. *E. coccinea* has been commercially cultivated for the local market and is used by indigenous ethnic groups to flavour foods such as "sambal tuhau" (paste), "jeruk tuhau" (pickles), and "serunding tuhau" (floss) (Jualang et al. 2015). According to Naïve et al. 2018, the pith of the leafy shoot is used as a condiment in Borneo and Java and is also eaten as a vegetable. It is traditionally used to treat stomach aches, urine cleanser, food poisoning and gastric problems (Poulsen, 2006; Vairappan et al. 2012; Shahid-Ud-Daula et al. 2015; Devanathan & Mustaqim, 2020). The local also utilized it as a wound healer and removing body odour during the postpartum period (Lee, 2017; Geraldine, 2017).

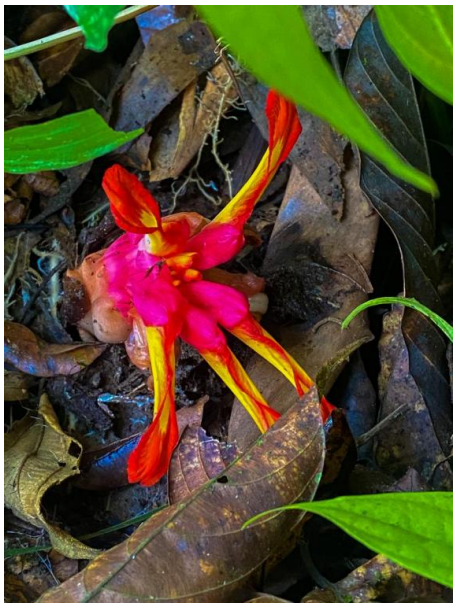

Figure 1. The yellowish-red flowers of *E. coccinea* are shown. (Naïve et al. 2018) (Photo by Emmeldah Joseph)

Figure 2. The fruits of *E. coccinea*. (Naïve et al. 2018) (Photo by Emmeldah Joseph)

Methods

The aim of this paper is to review studies of Tuhau that has been reported by previous research studies database from reviewed literature platforms between 2008 to 2021. This study consists of collecting and selecting journal articles, which were then analysed based on objectives stated from the selected articles. This research will be presented in extracted information in table and figures and performed with descriptive analysis. The research framework is illustrated in **Figure 2.1**.

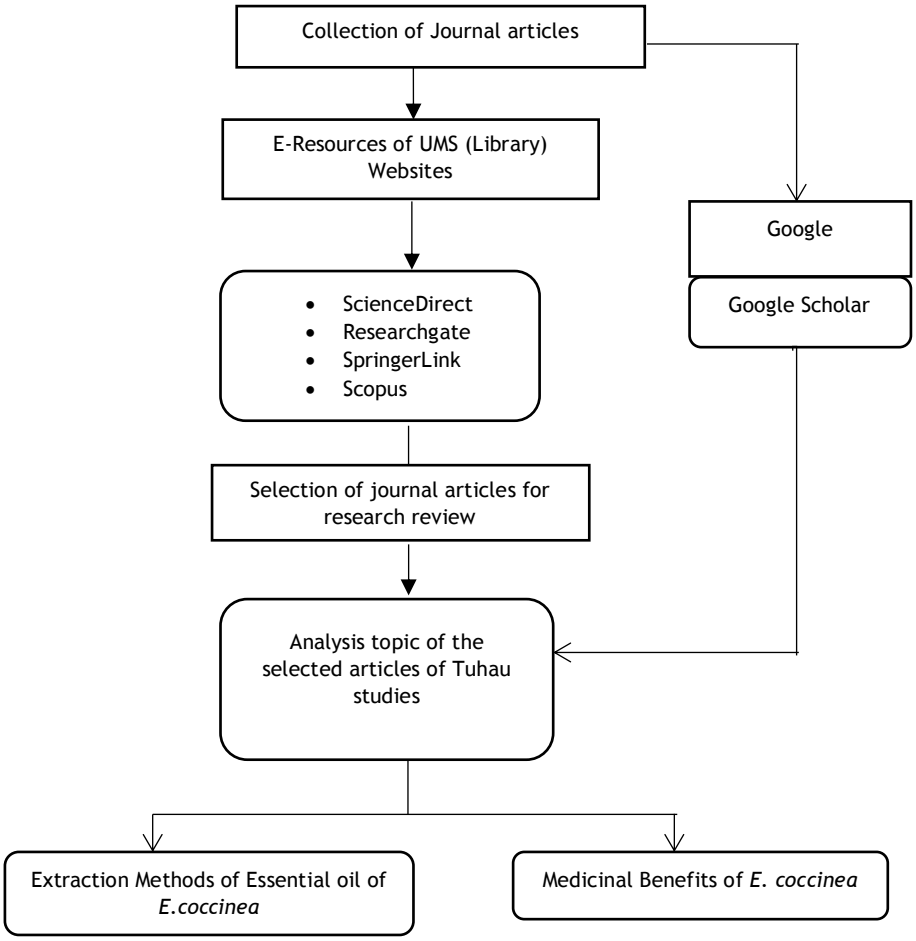

Figure 2.1 Research Framework for Review of Tuhau.

Literature Searching and Data Collection

A systematic search of peer-reviewed literature from e-Resources under the official website, Universiti Malaysia Sabah (subscribe database: Scopus, ScienceDirect, Researchgate and SpringerLink). The search for relevant research papers for data collection were also obtained from Google Scholar. The following search strings are used such as "*E. coccinea*" and "Tuhau".

Analysis topic of the selected articles of Tuhau studies on Extraction Methods of Essential Oils

The selected articles for this study were documented between 2008 to 2021. Various extraction methods are performed to acquire essential oils. For instance, hydro-distillation, solvent extraction, effleurage, aqueous infusion, cold or hot pressing, supercritical fluid extraction, solvent free microwave extraction and phytonic process (Shahid Ud-Daula & Basher, 2019). **Table 1** shows the methods used to extract essential oil of *Etlingera coccinea* as documented in previous research studies.

Table 1 Extraction Method Used to Achieve Essential oil of *Etlingera coccinea* spp.

Article Title	Extraction Method Used	References
Allelopathic Potential of *Etlingera coccinea* (B.) Sakai & Nagam on Seed Germination and Growth of Mung Bean and Siam Weed.	10 g of powdered stems and leaves were soaked 48 hours in 100mL of 80% of three different solvents (hexane, ethyl acetate and methanol) using cold maceration method.	Mohamad et al. (2021)
The Anti-Candida Studies on Edible Gingers of Sabah.	500 g stalks of tuhau were soaked 96 hours in 100 mL of analytical grade (AR) methanol.	Hafiz et al. (2008)
Diversity in Volatile Chemical and Antibacterial Activity Among Selected Genus of *Cinnamomum*, *Etlingera* and *Schizostachyum* From Sabah.	Hydro-distillation: 200g freshly chopped rhizome were hydro-distilled for 8 hours via Clevenger-type apparatus.	Nagappan et al. (2017)
Essential Oil Composition, Cytotoxic and Antibacterial Activities of Five Etlingera Species from Borneo.	Hydro-distillation: 200 g freshly chopped rhizomes were hydro-distilled for 8 hours via Clevenger-type apparatus.	Vairappan et al. (2012)
Investigation on the antimicrobial activities of gingers (*Etlingera coccinea* (Blume) S.Sakai & Nagam and *Etlingera sessilanthera* R.M. Sm) endemic to Borneo.	Leaves and rhizomes were crushed and then extracted using hexane, dichloromethane, ethyl acetate, methanol and distilled water for 15 minutes followed by filtration respectively.	Daniel-Jambun et al. (2017)
The Protective Effect of *etlingera coccinea* (TUHAU) against Autoxidation -induced Ox Brain Homogenate	Aqueous Extraction: 1g of powdered leaves mixed with 100 ml distilled water was boiled for 10 minutes and then cooled for 15 minutes.	Anuar et al. (2018)
Chemical Composition of Essential Oil from *Etlingera coccinea*.	Hydro-distillation: 250-300g leaves chopped and hydro-distilled at 100°C for 7 to 8 hours.	Jems et al. (2021)

As shown in **Table 1**, most of the previous studies use hydro-distillation as extraction method of essential oils of *E. coccinea* spp. As mentioned by Shahid Ud-Daula & Basher (2019), hydro-distillation and steam distillation are extensively used for extracting essential oil from plants nowadays. This is

because the volatile components can be distilled at lower temperature than their individual boiling points and can also be separated easily from condensed water.

Medicinal Uses of Etlingera coccinea

Past studies found that essential oil extracted from *E. coccinea* spp., have volatile compounds which reveal the potential of selected plants used by indigenous communities of Borneo as antimicrobials in food, cosmetics and pharmaceutical industries. Many pharmacological activities have been reported on *Etlingera* genus especially, including their benefits as antioxidants, antibacterials, cholesterol-lowering and anti-cancer (Wahyuni et al. 2021).

Table 2. Medicinal Benefits of *E.coccinea* (Tuhau).

Parts of Plant and Preparation	Medicinal Benefits	References
Young shoots	Treat stomach ache Food poisoning Gastric problems	(Kulip, 1997; Poulsen, 2006) (Subramaniam et al. 2010; Vairappan et al. 2012) Shahid-Ul-Daula et al. (2015) Devanathan & Mustaqim (2020)
Essential Oil extracted from rhizome of *Etlingera coccinea* spp.,	Antimicrobial Inhibit the four strains of clinical bacteria (*Staphylococcus aureus, Staphylococcus* sp., *Streptococcus pyrogenes* and *Salmonella enteriditis*) with MIC values less than 10 µg/mL. Display best inhibition against *Listeria monocytogenes* (MIC: 4.60 ± 0.5 µg mL-1)	Vairappan et al. (2012) Nagappan et al, (2017)
Essential Oil extracted from leaves of *Etlingera coccinea* spp.,	Anti-inflammatory Anti-depressant agent	Rivas da Silva et al. (2012) Guzman-Gutierrez et al. (2012)
Young shoots immersed into hot ash (squeeze the extract before consuming)	Cure cough & wounds	Handayani (2015)
Young shoots	Wound healer and helps to eliminate body odour during postpartum period	Lee (2017); Geraldine (2017)

Table 3. Shows the comparison between past research reported on Microbial activities of *E.coccinea* essential oils against microorganisms.

References	Method Used	Microorganism	Volatile Compounds
Vairappan et al. (2012)	Agar Dilution Method	*Staphylococcus aureus, Staphylococcus* sp., *Streptococcus pyrogenes,* (*Salmonella enteritidis*	3-Thujanone, Borneol (25.8%), Camphor (3.8%), Cedr-9-ene, L-Calamenene, Carophyllene oxide, α-Bisabol, α-Epi-muurolol and Cycloartanyl acetate.
Nagappan et al. (2017)	Agar Dilution Method	*S. aureus* (ATCC 29213), *L. monocytogenes* (ATCC 7644), *S. typhimurium* (ATCC 25922) and *S. enteritidis* (ATCC 29213).	Borneol (28.2%), Aromadendrene oxide (10.9%), Elemicin (9.7%), Lauryl aldehyde (5.9%), 1-dodecanol (3%), Camphor (2.8%) and 5-Decen-1-ol (1.3%)

Conclusion

According to data collected, the extraction method often used to derive essential oils of *E. coccinea* is hydro-distillation. The volatile compounds found in *E. coccinea* proved its ability in the medicinal industry hence increasing its value in the market. However, the rising demand from local use and start-ups of industries around tuhau-based food poses a real risk of overharvesting especially from the wild. Therefore, further studies such as understanding its distribution, environmental aspects and sociology of this species need to be done to provide alternative sources for these natural plants to reduce the pressure especially on the wild population.

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