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Review Article

RHODOMYRTUS TOMENTOSA (AITON) HASSK. AND ITS BIOLOGICAL ACTIVITIES: AN OVERVIEW

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ABSTRACT

Rhodomyrtus tomentosa (Aiton) Hassk., locally known as Sim, is a flowering plant belonging to the family Myrtacea, native to southern and southeastern Asia. It have been used in traditional Vietnamese, Chinese and Malaysian medicine for a long time for treatment of diarrhoea, dysentery, gynaecopathy, stomachache, and wound healing. Moreover, sim fruits are used to make various health-beneficial products such as Sim wine, Sim tea, Sim jam, etc. Notably, R. tomentosa have been known to contain a rich source of structurally diverse and biologically active metabolites, thus considering as a potential resource for exploring novel therapeutic agents. In this contribution, an overview of R. tomentosa and its biological activities is emphasized.

KEY WORDS: R. tomentosa, Sim fruit, biological activity, antioxidant, phenolic compound.

1. Description of *R. tomentosa* (Aiton) Hassk

R*. tomentosa* is flowering plant in the family of Myrtaceae (Figure 1A). It grows up to 2-meter-tall and mainly distributes in South-East Asian countries, especially Southern parts of Vietnam, China, Japan, Thailand, Philippines, and Malaysia. The leaves are opposite, 5-7 cm long and 2-3.5 cm broad, three-veined from the base, oval, obtuse to sharp pointed at the tip, glossy green above, densely grey or rarely yellowish-hairy beneath, with a wide petiole and an entire margin. The flowers are solitary or in clusters of two or three, 2.5-3 cm diameter, with five petals which are tinged white outside with purplish-pink or all pink (Figure 1B). The sim fruit is an ellipsoid berry that measures 1–1.5 cm in diameter with a persistent calyx. Unripe fruits have a green skin and astringent taste. It turns to a purplish black colour when ripe with the pulp being purplish in colour, soft and sweet (Figure 1C). There are many deltoid seeds that measure 1.5 mm in diameter and locate in 6 (-8) pseudo-locules, divided by thin false septa (Lim, 2012; Jie and Craven, 2007).

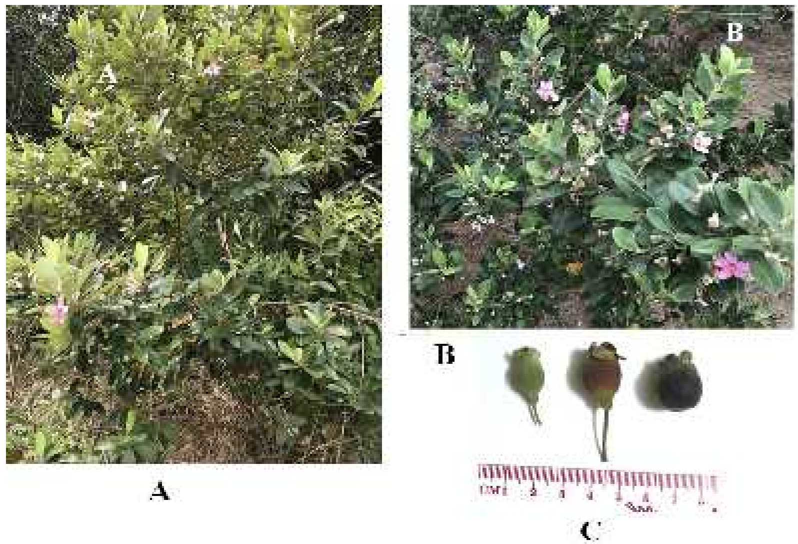

Figure 1. *Plant (A), leaf and flower (B), and fruit (C) of Rhodomyrtus tomentosa*

2. Ecology

R. tomentosa grows in moist and wet forests up to 2400m elevation, on poor sand soils. It tolerates full sun and flooding. Moist, somewhat acid soils are preferred. The plant is not well adapted to limestone soils. It is able to invade a range of habitats, from pine flatwoods to mangrove marshes. It grows in a wide range of soil types, including salty coastal soil, but is sensitive to heavy salt spray. It is fire-adapted that is able to resprout prolifically after fire. It has the potential to alter the natural fire regimes of invaded areas (http://www.asianplant.net/Myrtaceae/Rhodomyrtus_tomentosa.htm).

3. Nutritional composition of sim fruit

For the first time, the detailed chemical properties of sim fruit including nutritional composition and phenolic content were reported by Lai and colleages (Lai et al., 2015). In this study, protein content and amino acid composition, carbohydrates, lipid and fatty acid composition, minerals, and vitamins were determined. It was found that sim fruits contain low level of total protein (4.00 ± 0.12% DW). Meanwhile, it contains various amino acid, especially tryptophan, a precursor for the synthesis of serotonin, involved in mood, behaviour, and cognition. Moreover, the sim fruit was found to have a remarkably high concentration of total dietary fibre (66.56 ± 2.31% DW). Soluble dietary fibres (SDF) represented only 7.60% of the total dietary fibre content. Most insoluble fibres found in sim fruit were cellulose, which contributed to about 50% of the insoluble dietary fibres. Contrary to dietary fibres, the digestible sugar content of the sim fruit sample was not high (19.96% DW) as compared with that of other tropical fruits. Besides, the sim fruit contains a low level of lipids (4.19 ± 0.07% DW). The most abundant fatty acids in sim fruit were linoleic and palmitic acids, which contributed to 75.36% and 10.45% of total fatty acids, respectively. The analysis of sim fruit giving us a clear observation regarding minerals and vitamines. It contains different minerals with high level of potassium (221.76 mg/serving) and calcium (73.65 mg/serving), manganese (3.23 mg/serving), iron (1.54 mg/serving), zinc (0.61 mg/serving), and copper (0.40 mg/serving). Meanwhile, vitamin C content of the sim fruit sample (5.62 mg/serving) was much lower than that of other tropical fruits and the vitamin E level (3.89 mg/serving) was higher than that of mango and avocado.

Notably, the sim fruit sample presented a total phenolic level (49.21 ± 0.35 mg GAE/g DW), which is two times higher than the value reported in the sim fruit harvested in Hong Kong (24 ± 0.04 mg GAE/g DW) (Huang et al., 2010). When compared with other fruits, the sim fruit has a similar total phenolic content as berries, which are known as good sources of phenolic compounds and antioxidant activities (Wu et al., 2004).

4. Biological activity research

4.1. On the world

The extract and purified compounds from *R. tomentosa* possess strong anti-oxidant and anti-bacterial activities. According to Dachriyanus and colleagues, the methanolic extract of *R. tomentosa* leaves showed significant antimicrobial activities to inhibit *Escherichia coli* and *Staphylococcus aureus*. Bioassay-guided chromatography of this fraction revealed the isolation of active compound in acylphloroglucinol class, rhodomyrtone (Dachriyanus et al., 2002). Similarly, Saising et al. (2008) have proved that rhodomyrtone isolated from this plant species was very effective against *S. aureus* ATCC 25923 with the MIC value at 0.5 µg/ml which is very closed to that of vancomycin (Saising et al., 2008). In another study, rhodomyrtone was reported to have a strong bactericidal activity on gram-positive bacteria such as *Bacillus cereus, B. subtilis, Enterococcus faecalis, methicillin-resistant S. aureus (MRSA), S. epidermidis, S. gordonii, S. mutans, S. pneumoniae, S. pyogenes,* and *S. salivarius* (Limsuwan et al., 2009). Furthermore, the anti-staphylococcal activity of an ethanol extract of *R. tomentosa* and its pure compound, rhodomyrtone, as well as their effects on staphylococcal biofilm formation and biofilm-grown cells were also determined by Saising and co-workers (Saising et al., 2011). Especially, rhodomyrtone was revealed to be able to enhance the expression of local host immunity against *S. aureus* infections (Srisuwan et al., 2014).

Beside of antimicrobial activities, numerous reports have been shown the antioxidant of *R. tomentosa* and its compounds. Cui et al. (2013) have purified 6 anthocyanins from the fruits of *R. tomentosa* and their activity was found to be strong antioxidant agents via DPPH radical-scavenging capacity, ABTS radical scavenging capacity, reducing power and oxygen radical absorbance capacity. Lavanya et al. (2012) evaluated both *in vitro* and *in vivo* antioxidant activities of *R. tomentosa* leaf extract. *R. tomentosa* extract was found to be capable on free radical scavenging activity, and thus inhibiting lipid peroxidation, increasing ferric reducing antioxidant power and metal chelating activity. *In vivo* antioxidant activity of the extract was identified via decreasing levels of thio-barbituric acid reactive substances and increasing GSH, SOD, CAT and GPx levels in blood, liver, and kidney of mice fed *R. tomentosa* extract. The optimal condition of spray drying purified flavonoids extract from *R. tomentosa* berries and their antioxidant via DPPH radical scavenging activity was also studied by Wu et al. (2014). On the other hand, the rabbit fed with *R. tomentosa* fruit extract (50 mg/kg) caused a significant reduction in total cholesterol, low density lipoprotein, and lipid peroxidation and a remarkably increase in high density lipoprotein and triacylglycerides, thus contributing to reduce hypertension and obesity (Maskam et al., 2014). The aqueous alcoholic (70%) extract of *R. tomentosa* was investigated for its anti-ulcerogenic activity using acetic acid-induced chronic ulcer model in rats. The reduction in ulcer index followed by increase in the levels of superoxide dismutase and catalase and decrease in lipid peroxidation proved the antiulcer and antioxidant activity of the extract (Geetha et al., 2010). Additionally, piceatannol 4'-O-β-D-glucopyranoside was purified from ethanol extract of dried fruit of *R. tomentosa* showed superoxide-scavenging activity at IC_{50} of 81.7 µg/ml and it also stimulated the proliferation of cultured human skin fibroblasts and normal human epidermal keratinocytes (Nojima et al., 2007).

4.1.2. In Viet Nam

In Vietnam, the studies on purification and identification of bioactive compounds from *R. tomentosa* were also gained much attention. Tung et al. (2009) isolated two new anthracene glycosides from aerial parts of *R. tomentosa* and their biological activities was revealed due to increasing the alkaline phosphatase activity, collagen synthesis, and mineralization of the nodules of MC3T3-E1 osteoblastic cells significantly. Nhan Minh Tri (2013) optimized conditions for extraction of syrup from Sim fruit *R. tomentosa* to obtain high anthocyanin concentration and good quality. Le Phuc Ho (2015) investigated the effects of two technical parameters, core/wall ratio and inlet temperature of drying agent, on the retention of antioxidants in the sim powder during the drying process. Decrease in core/wall ratio from 1:4 to 1:5 reduced the antioxidant retention due to high viscosity of the feed solution. When the inlet temperature of drying agent augmented from 150 to 180 ^{o}C, the moisture content of the powder decreased and the retention of antioxidants increased. Meanwhile, increase in inlet temperature from 180 to 190 ^{o}C had detrimental effect on the antioxidant retention during the spray drying of Sim juice. Vo and Le (2014) also examined the effects of ultrasonic power and time on the level of total phenolics and ascorbic acid in *R. tomentosa* juice. Ultrasonic treatment significantly improved both antioxidant content and activity of the extract. The optimal ultrasonic power and time were 25 W/g and 6.5 min, respectively under which the concentration of total phenolics and ascorbic acid in the extract achieved 6,067 mg gallic acid equivalent (GAE)/L and 516 mg/L, respectively. Meanwhile, Hoang et al. (2015) determined the optimal conditions for extraction of polyphenolic compounds with high antioxidant capacity from *R. tomentosa*. Under the optimal conditions, 65% ethanol, 45°C, and for 30 min, the total polyphenol content of 76.42 mg GAE/g dry weight and antioxidant capacity of 1408.99 µM TE/g dry weight were achieved. Recently, various phenolic compounds from *R. tomentosa* fruit were tentatively characterised and included stilbenes and ellagitannins as major components, followed by anthocyanins, flavonols, and gallic acid (Lai et al., 2013). Piceatannol, a promising health-promoting stilbene component, was the major PC in the fruit with a concentration of 2.3 mg/g dry weight at full maturity stage. This concentration is 1000–2000 times higher than that of red grapes, a major source of stilbene in the human diet. For the first time, Lai et al. (2015) have determined the detailed chemical properties of Sim (*R. tomentosa*) fruit including nutritional composition, phenolic content and antioxidant capacity. They indicated that a 150 g serving of sim fruit contained high levels of dietary fibre (69.94–87.43% of Recommended Daily Intake (RDI)), α-tocopherol (38.90–51.87% RDI), manganese (>100% RDI), and copper (44.44% RDI) but low levels of protein (2.63% RDI), lipid (1.59–3.5% RDI), and sugars (5.65% RDI). The predominant fatty acid in the sim fruit sample was linoleic acid (75.36% of total fatty acids). Interestingly, total phenolics (49.21 mg GAE/g dry weight) were particularly high and resulted in a high antioxidant capacity.

5. Application

In some areas, jam or jelly used to be made from the fruit. In Malaysia, it has been mentioned that the fruits can be used as a cure for dysentery and diarrhoea. A decoction of the roots or leaves is drunk for diarrhoea and stomachache, and as a protective medicine after birth. In Indonesia, the crushed leaves are used to dress wounds. In Java and in Florida, *R. tomentosa* is cultivated in gardens, and its flowers is prized. It has shown promise as a fire-retardant species for use in fire breaks in the Himalayas. Nowadays, the use of sim fruit is increasing in Vietnam. In addition to being used in folk medicine, sim fruits are used to make a famous fermented drink called ‘‘Ruou sim’’ at Phu Quoc island, in the south of Vietnam. Cultivation of the sim plant to harvest fruits and to produce ‘‘Ruou sim’’ have done in Phu Quoc island and extends to many provinces in the south and center of Vietnam.

6. Conclusion

Accordingly, *R. tomentosa* is able to grow in a wide range of ecological conditions. A range of compounds including triterpenes, steroids, and especially phenolic compounds has been identified from this plant. Therefore, it may contribute to the values of *R. tomentosa* to be useful as traditional medicine in many countries as well as its biological activities such as anti-bacterial, anti-oxidant, anti-ulcerogenic, anti-hypertensive, and immune-enhancing effects. The further studies regarding its chemical components and pharmacological properties will discover the different values of *R. tomentosa*, thus can be applied to produce various health benefit products such as beverages, cosmeceuticals, and pharmaceuticals.

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