

## **Botany, uses, chemistry and bioactivities of mangrove plants III: *Xylocarpus granatum***

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### **Introduction**

*Xylocarpus* of the family Meliaceae is a small genus comprising tree species of *X. granatum*, *X. moluccensis* and *X. rumphii* (Giesen *et al.*, 2007). Considered as true mangroves, *X. granatum* and *X. moluccensis* are found at the landward side of mangrove forests and in associated brackish-water habitats while *X. rumphii* occurs along rocky shores and promontories. The geographical range of these species stretches from East Africa through South and Southeast Asia to the Pacific Islands. To-date, there are several reviews on the chemical constituents and pharmacological properties of *Xylocarpus* species (Lakshmi & Gupta, 2008; Wu *et al.*, 2008; Shen *et al.*, 2009; Das *et al.*, 2014). This short review is probably the first on *X. granatum*.

### **Botany and Uses**

*Xylocarpus granatum* Koenig (synonym: *Carapa granatum*) is a medium-sized, evergreen tree that grows up to 20 m in height (Giesen *et al.*, 2007). Supported by buttresses and plank roots, the trunk often has a hollow core. The bark is light brown, thin and flaky (Figure 1). Borne on dark brown twigs, leaves are compound, spirally arranged and leaflets are 1–2 pairs. Each leaflet is green, ovate, thick and leathery with a rounded tip. Inflorescences are a panicle and mainly axillary in position. Either hermaphrodite or female, flowers are clustered, small with four-lobed yellowish-green calyx and four creamy to white oval-shaped petals. Fruits are large, round, woody, 12–25 cm in diameter and resemble a cannon ball (Figure 2). Green when young and brown when mature, fruits have four compartments, containing up to 10 corky seeds that are buoyant for water dispersal.

*Xylocarpus granatum* is used as a folk medicine in Southeast Asia for the treatment of diarrhoea, cholera and malaria, and as anti-feedant (Champagne *et al.*, 1992; Mulholland & Taylor, 1992). The astringent bark of *X. granatum* is used to treat dysentery, diarrhoea and other abdominal troubles, and as febrifuge (Rudjiman, 1991; Saxena & Babu, 2001). The fruit is used as a cure for breast swelling and elephantiasis. Mixed with sulphur and coconut oil, the seed ash is applied as ointment for itch. The bark, fruit and seed are used as remedy for cholera and diarrhoea (Giesen *et al.*, 2007). The wood of *X. granatum* can be used for carving sculptures but that of *X. moluccensis* is preferred (Baba *et al.*, 2013). The Mah Meri aboriginal community of Carey Island in Selangor, Malaysia, carves unique spiritual sculptures from the wood of *Xylocarpus* (Figure 3).



**Figure 1** Bark (left) and leaves (right) of *Xylocarpus granatum*



**Figure 2** Fruit (left), opening a fruit to count the seeds (middle) and seeds (right) of *Xylocarpus granatum*



**Figure 3** Spiritual sculptures carved from *Xylocarpus* wood (left) and a young *Mah Meri* craftsman at work (right)

## Chemistry

The chemical constituents of *Xylocarpus* include triterpenoids, alkaloids, phenolics and steroids (Shen *et al.*, 2009). Of these compounds, limonoids or tetranortriterpenoids are the dominant constituents. Limonoids are structurally diverse and can be classified into gedunins, phragmalins, mexicanolides, obacunols and andirobins. These triterpenoids have a wide range of biological activities (Shen *et al.*, 2009; Wu *et al.*, 2008, 2014).

From *X. granatum*, more than 50 types of limonoids have been isolated (Wu *et al.*, 2006a, 2014). The seed, stem bark, root bark and fruit yielded limonoids of gedunin, xylocensins, xylogranatins, xylocarpins, granaxylocarpins and xylomexicanins (Shen *et al.*, 2009; Wu *et al.*, 2006a, 2014). From the seed, protolimonoids of tirucallanes and apotirucallanes have also been identified (Yin *et al.*, 2009). Earlier, alkaloids, phenolics and steroids have been isolated from the root bark and fruit of *X. granatum* (Chou *et al.*, 1977; Wu *et al.*, 2006b; Zhou *et al.*, 2006). Recently, two terpenoids and a polyketide (harzianone, trichoacorenol and trichodimerol) were isolated from an endophytic fungus of *X. granatum* (Zhang *et al.*, 2014).

## Bioactivities

**Seed:** Of the xylomexicanins E–H isolated from seeds of *X. granatum*, xylomexicanin F showed activity against A549 and RERF human cells with IC<sub>50</sub> values of 18.8 and 15.8 mM, respectively (Wu *et al.*, 2014).

**Bark:** Gedunin, isolated from the bark of *X. granatum* inhibited the growth of CaCo-2 colon cancer cells with IC<sub>50</sub> value of 16.8 mM (Uddin *et al.*, 2007). Anti-diarrhoeal properties of the methanol bark extract of *X. granatum* was assessed in mice with diarrhoea induced by castor oil and magnesium sulphate (Rouf *et al.*, 2007). At oral doses of 250 and 500 mg/kg, the bark extract showed significant and dose-dependent anti-diarrhoeal activity in both models. At 400 µg/disc, the ethanol bark extract of *X. granatum* inhibited the growth of six out of 10 bacterial species, with *Staphylococcus epidermis* and *Shigella boydii* being the most susceptible (Alam *et al.*, 2006). Other properties of *X. granatum* bark extracts included antibacterial (Shahid-Ud-Daula & Basher, 2009) and cardiotoxic (Trilochana *et al.*, 2013) properties.

**Fruit:** The fruit extract of *X. granatum*, and its active constituents of gedunin and photogedunin have been reported to show significant anti-secretory effects and protection against peptic ulcer in rats (Lakshmi *et al.*, 2010), and to possess anti-filarial activity (Misra *et al.*, 2011). Other properties of fruit extracts included anti-diarrhoeal (Lakshmi *et al.*, 2011), and anti-diabetic and anti-dyslipidemic (Srivastava *et al.*, 2010) activities.

**Different plant parts:** Aqueous extracts of fruits, seeds and leaves of *X. granatum* were tested against adult worms of *Brugia malayi* (Zaridah *et al.*, 2001). The relative mobility (RM) of the worms over a period of 24 h was used as a measure of the anti-filarial activity of the extracts. The seed extract displayed the strongest activity based on RM values. The ethanol leaf and bark extracts of *X. granatum* showed anti-diarrhoeal activity in castor oil-induced diarrhoeal rats, including antimicrobial activity against Gram-positive bacteria and yeast (Rao *et al.*, 2003).

## Conclusion

Endowed with a rich source of limonoids or tetranortriterpenoids, *X. granatum* has properties of anti-diarrhoeal, antibacterial, anti-filarial, cytotoxic, anti-ulcer, anti-diabetic, anti-dyslipidemic and cardiotoxic activities, which confer its traditional uses as a medicinal plant from the mangroves.

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