

Learning Pharmacognosy with Urban Callistemon Flora

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ABSTRACT

This paper discusses a plant genus, botanically called Callistemon. The species is indigenous to Australia, yet locally available as the ornamental horticulture. Walking passes its hanging red flowers would be like brushing the shoulders with bottlebrush, hence its vernacular name. In this mini project, a literature review is conducted to study its traditional values, natural product chemistry, and its environmental role. From the web articles and online botanical resources, this genus is an ideal suggestion for roadside and parks landscaping. The contribution of Callistemon in traditional Malay practice is undocumented, due to the non-native character of this tree. The natural constituents were chemically investigated, and it was reported to contain secondary metabolites, for example, the plant steroids. The environmental role of Callistemon is contributed owing to its dense foliage, rapid growth and resilience against strong wind. It is anticipated that more specimens could be witnessed and enjoyed by the society. City councils and property developers could include this genus as one of the educational and biological materials for the public knowledge and plant heritage. It is hoped that this writing provide information on Callistemon's scientific investigations, at the same time, suggesting this urban flora as a live specimen, while teaching and learning the pharmacognosy lesson for pharmacists-in-training.

Keywords: Course, Bottlebrush, Pharmacognosy, Pharmacy

INTRODUCTION

The natural and planted plants could provide inspirations and motivation to the campus citizens (The University of Sydney, 2025). In Universiti Teknologi MARA (UiTM) Puncak Alam campus [Universiti Teknologi MARA Cawangan Selangor (UCS), 2026], the papery flowers or the Bougainvilleas offer delights to the local (Figure 1). This Bougainvillea is a genus of thorny ornamental vines, bushes, and trees, well known most to the varsity population. While in the Faculty of Pharmacy, the pharmacy undergraduates also learn about plants and their anatomy in the pharmacognosy course. In this paper, a literature review is performed to introduce another ornamental, yet unrelated horticulture and less known species, called the bottlebrush (Figure 2 and 3) or Callistemon genus.



Figure 1: The popular Bougainvilleas show papery, bright colours of red and pink flowers at the Zamrud Road, in Universiti Teknologi MARA (UiTM), Puncak Alam campus, Selangor Darul Ehsan.

LITERATURE REVIEW ON CALLISTEMON

Callistemon is a genus of shrubs in the family Myrtaceae. The genus contains about 34 species (Abdelmalek et al. 2021). The entire genus is endemic to Australia and now widely cultivated in Egypt, India, Malaysia and Korea. The Malaysia Biodiversity Information System (MyBIS) recorded four Callistemon species, namely *C. citrinus* (crimson bottlebrush), *C. lanceolatus*, *C. polandii* and *C. viminalis* as the non-native plants (MyBIS, 2024). Their taxonomic status is currently pending for approval. The members of this genus are known for their decorative values. These species are commonly called as bottle brush trees (Figure 2 and 3) because of their cylindrical brush-like flowers, resembling a bottle brush (Kim et al. 2012). From the author's knowledge, this plant is not yet planted in the campus. Yet, it is recommended by the property developer nearby to beautify the scenery with its red flowers (Eco World Development Group Berhad, 2026). It can grow from 3 to 6 m (10 to 20 feet) tall and has lance-shaped leaves and bright red stamens (male parts). The axis of the inflorescence can continue growing beyond the head of the flowers to produce new leaves (Figure 2 and 3) (BRAHMS Online, 2026). Recently, two toxicity studies of Callistemon extracts were unveiled (Eissa et al. 2026; Rabie et al. 2026).

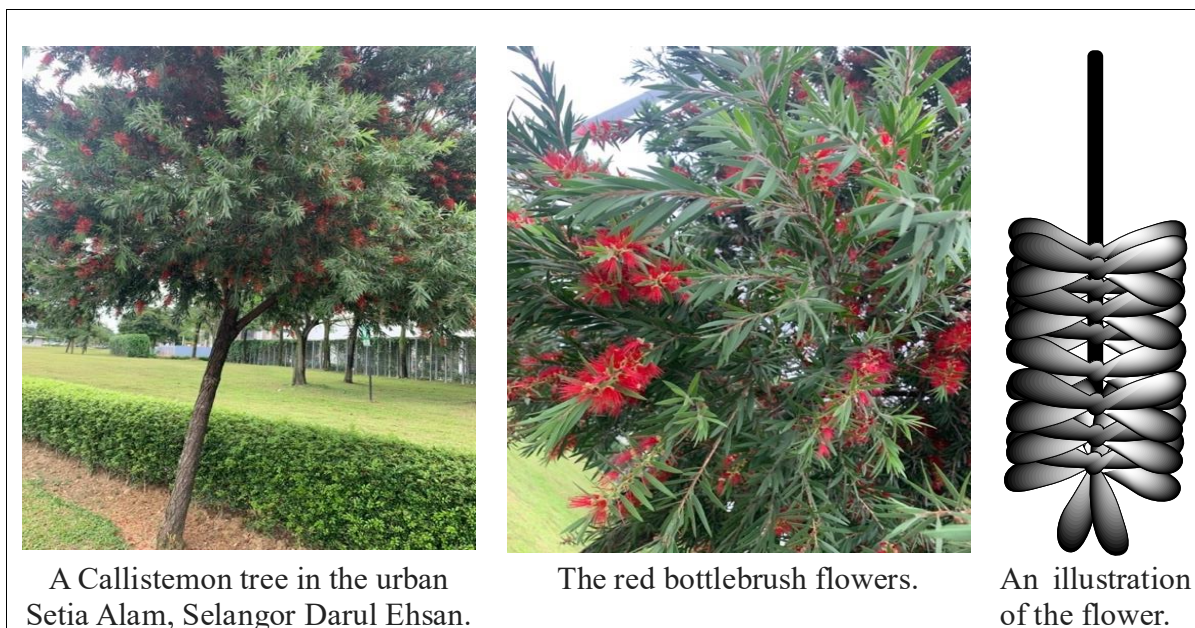


Figure 2: An example of a Callistemon tree (left) and its red flower (middle). An illustration showing the bottle brush flower (right), the eponym of the plant. The tree is named after the flower's shape of a bottle brush (author's own collection).



Figure 3: A closer look at the Callistemon red flower (left) and its measurement of the bottlebrush-like inflorescence (about 7 cm of length, right).

Discussion on the Callistemon Genus and Its Relation to Pharmacognosy Lessons

The review on Callistemon is listed in Table 1. Goyal et al. (2012) and Abdelmalek et al. (2021) wrote on the phytochemistry and biological activities of Callistemon genus. Ahmad & Athar (2016) also published a review, specifically on the chemistry and pharmacology of *C. viminalis* (known as the weeping bottlebrush). The chemical analysis of the Callistemon genus provided a variety of essential phytochemicals (Abdelmalek et al. 2021), belonging to different classes including terpenes, phytosterols and polyphenolic derivatives. Meanwhile, the essential oils of *C. citrinus* and *C. viminalis* from South Africa were reported to possess an antibacterial activity (Oyedemi et al. 2009). It is noteworthy that the inspirations from natural bottlebrushes lead to a new generation of nanomaterials, as experienced and reported by the postgraduate researchers at the University of Sydney (Zeng et al. 2025). For undergraduate teaching and learning, the plant can be initially introduced during the pharmacognosy lessons on the plants with terpenoids and lipids (Table 2). This arrangement can be made, following the research articles supporting the scientific data on the genus (Oyedemi et al. 2009; Kumar et al. 2011; Kim et al. 2012; Salem et al. 2017). Other activities would include the students' presentation on the British Pharmacopoeia (BP) monograph, laboratory practical in isolating the essential oil (for example 1,8-cineol) and final year project in detecting plant sterols (Figure 4) from the leaf's samples.

Table 1: List of reviews on Callistemon.

Points	Source
A survey of literature on Callistemon and reported the isolation of plant steroids from leaves, seeds and stem bark of different Callistemon species.	Goyal et al. (2012)
A collective source of the various information regarding Callistemon lanceolatus, published in various journals and books.	Maria et al. (2015)
A review concerning the cultivation, morphology, microscopic studies, physiochemical, and phytochemistry of Callistemon viminalis.	Ahmad et al. (2016)
A review on phytochemistry and biological activities of Callistemon.	Abdelmalek et al. (2021)
Information on the physiochemical characteristics and phytochemical qualities of Callistemon viminalis.	Kumar et al. (2022)

Table 2: The brief description of the pharmacognosy course [Source: Massive Open Online Course (MOOC), UiTM, 2026].

Item	Brief content
1	Introduction to Pharmacognosy and Plant Taxonomy History, Definition and Scope of Pharmacognosy. Plants Classification, Taxonomy and Systematics of Morphological, Classification. Meristems Simple Tissue, Complex Tissue. Plant Architecture, Histology of the main types of plant tissues.
2	Plant Constituents and Sourcing Plant Material Good Agriculture Practice, Crude drugs, Sources of crude drugs. Plant cultivation, collection, drying of crude drugs. Herbarium specimen preparation and significance. Plant crude drug extraction.
3	Plant Anatomy/Microscopic Features
4	Plants containing terpenoids Introduction to types of terpenoids. Extraction and chemical tests. Bioactivity of terpenoids. Pharmaceutical and nutraceutical applications of terpenoids. British Pharmacopoeia (BP)

	Monograph related to terpenoids
5	Plants containing carbohydrates. Introduction, polysaccharides (pectin, gum, mucilage and cellulose). Bioactivity and pharmaceutical uses of carbohydrates.
6	Plants containing lipids (fixed oils, fats, and waxes) Introduction to plants containing nonessential oils. Extraction of plant oils/Lipids. Bioactivity of nonessential oils. Nutraceuticals containing nonessential oils. British Pharmacopoeia (BP) Monograph related to lipids.
7	Plants containing phenolics Introduction and physiochemical properties of phenolic compounds. Properties and characterization. Pharmaceutical and nutraceutical applications of phenolic compounds.
8	Plants containing alkaloids Introduction and physiochemical properties of alkaloids. Classification of alkaloids. Extraction and chemical tests. Bioactivity of alkaloids. Pharmaceutical and nutraceutical applications of alkaloids. British Pharmacopoeia (BP) Monograph related to alkaloids.
9	Normalisation/Standardisation Concepts Concept of normalization. Purity test, microbial heavy metal impurities tests. Different chromatographic procedure. Quality control of herbal drugs.
10	Regulation/Licence and Advertisement Registration of herbal medicine. Regulatory status of herbal drugs/products.

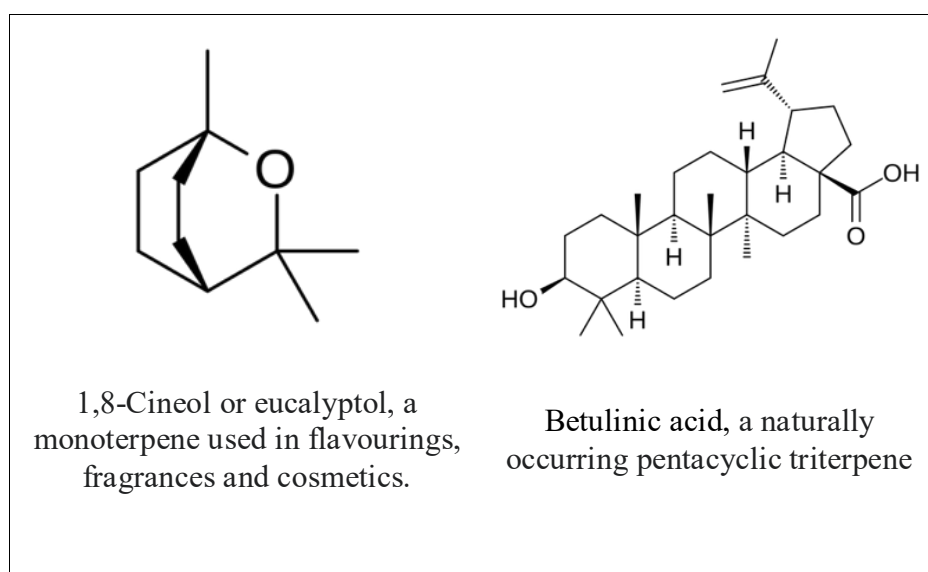


Figure 4: The structures of the chemicals in the natural essential oil of *Callistemon* species (Salem et al. 2017).

The phytochemical discussion on the *Callistemon* species could be expanded to include more specific information on the isolated major compounds and their pharmacological activities (Ibrahim & Moussa, 2020; Gogoi et al. 2021; Veryer et al. 2026). The list of *Callistemon* species, their major compounds, and

reported activities were summarised (Goyal et al. 2012; Ahmad et al. 2016). A more recent data of Callistemon's key compounds was tabulated (Abdelmalek et al. 2021).

The Pedagogical Rationale for Using Callistemon Flora in Pharmacognosy Education

This section briefly describes the pedagogical rationale for using Callistemon flora in pharmacognosy education. A concrete example of learning activities involving Callistemon could be provided, for example, a description on a laboratory practical for isolating 1,8-cineole (Rabie et al. 2026, Figure 4) or a student project on comparing essential oil profiles (Srivastava et al. 2003; Larayetan et al. 2017). In an instance, the fresh Callistemon leaves, flowers, stems and fruit part could be individually hydro distilled by using a Clevenger or Dean-Stark apparatus (Figure 5) for four hours. The essential oil from each part could be gathered and subjected to the gas chromatography-mass spectrometry (GC-MS) for a comparative analysis. With these suggestions, the explanation could be provided on why a lecturer would choose the Callistemon as the teaching material, the maceration as the specific choice for the extraction method (Saleh et al. 2024), and the laborious chromatographic activity (Xiang et al. 2017) to reach the learning goals. This type of experiential learning process would also allow the pharmacists in training to gain knowledge and skills through direct, firsthand experience in chemical analysis and critically reflect the extraction yield, rather than passive listening in the lecture halls.



Figure 5: The steam distillation apparatus, where the steam is generated in situ (in existing flask). It is a combination of a glass condenser and a flask for continuous removal of the water, that is produced during reflux. Four grams of dried Callistemon samples could be added with 100 mL of distilled water in a 250 mL round-bottom flask.

CONCLUSION

A walk on the roadside and neighbourhood path would have been like rubbing bottlebrush on the shoulders. The pseudo name of bottlebrush plant is due to the physical characteristics of the flowers. Their red filaments or inflorescences would provide the shape of a brush. By introducing place-based learning, the education experience would turn the local neighbourhoods, community parks, and natural landscapes into real-world classrooms for reading and crop science, particularly herbal chemistry, agriculture and agropharmacy. Researchers have been investigating the Callistemon genus and reported the chemical constituents. Various parts of different Callistemon species exhibit different medicinal importance and yet to be phytochemically investigated. The iconic Australian native flower would inspire Malaysian pharmacists and scientists all together. By the offering of the online pharmacognosy course, the students would be able to understand the field of herbal medicines or crude drugs, produced from natural sources such as the plants, microbes, and animals around the world. Further knowledge could be gained by including the analysis of their biological, chemical, biochemical, and physical properties.

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