Ocimum Species

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Ocimum is known to be one of the medicinal plants that have been used traditionally by local people. This plant contains components of secondary metabolites such as phenolics, flavonoids, steroids, terpenoids, and alkaloids.

Keywords: Ocimum species ; chemical constituents ; Antibacterial Activity

1. Introduction

Infection by microbes is one of the main problems that causes several diseases. One of the causes of infection is bacteria that can have an impact on public health. Based on the collection of data from 52 sentinel hospitals in North America for 7 years (1998–2004) on contemporary strains of 12,737 strains of pediatric patients under 18 years of age, *E. coli* as a pediatric pathogen ranks in the top six [1]. Mapanguy et al. [2] also reported that oral antibiotics such as cefixime, amoxicillin, and ciprofloxacin were resistant to *E. coli* infection about 50–60%. In addition, microorganisms can also cause wound infections and inhibit healing. Some of the bacteria associated with wound infections are *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Streptococcus pyogenes*, *Proteus* spp., *Streptococcus* spp., and *Enterococcus* spp. [3][4]. Bacteria is also can be pathogenic in the skin, such as *Staphylacoccus*, *Micrococcus*, and *Corynebacterium* sp. [5]. In relation to dental and oral health, *Streptococcus sanguinis* and *Streptococcus mutans* can cause dental caries [6].

Some of the infections mentioned can be treated with antibiotics. However, several studies have proven that antibiotics can cause resistance [7]. Antibiotic resistance occurs due to the use of drugs in large quantities, causing selection pressures on human and natural microbial systems. Microbes can undergo mutations to survive, thereby reducing antibiotic sensitivity [8][9]. Infections due to drug resistance have caused the death of up to 700,000 people every year worldwide [10]. There are several antibiotic resistances, namely vancomycin and teicolanin against *S. aureus* [11], gentamicin aminoglycoside against *E. faecalis* and *E. faecium* with percent resistance of 30% to 50% [12], penicillin against *S. pneumonia* [13], and *E. coli* caused resistance of fluorokuinolon more than 80% and gentamicin more than 40% [12].

Therefore, the use of natural antibacterial ingredients is one solution that has great potential. *Ocimum* species are herbal plants that are available in Indonesia. *Ocimum* species are native to tropical areas such as southern Asia, Africa, and India [14]. *Ocimum* comes from the *Lamiaceae* family, which has about 50 to 150 species [15]. Due to its pharmacological effects, this plant has been widely used traditionally for the treatment of headaches, coughs, diarrhea, constipation, warts, and kidney damage [16]. These properties come from the secondary metabolite components that are abundant in *Ocimum* plants such as steroids, tannins, alkaloids, flavonoids, and phenolics [17]. In addition, the abundant components of essential oils make *Ocimum* a plant that can fight the growth of organisms [18][19].

2. Chemical Constituents and Antibacterial Activity of *Ocimum* Species

2.1. Ocimum americanum

O. americanum is native to Africa and is 15 to 60 cm tall with sub-rectangular striated branches [20][21]. The leaf shape is intact or faintly serrated, lanceolate ellipse, glandular spots, and glabrous. The color of flower is pink, white, or purplish with an elongated circle shape. The fruits are small, pitted notelets, and mucilaginous [21]. It is commonly known as hoary basil or mosquito plant and has three chemotypes, namely spicy, camphoraceous, and floral-lemony [22] Traditionally, this plant is used for the treatment of digestive, respiratory, and sedative disorders. It also has benefits as a cough medicine, treating bronchitis, immune disorders, relieving toothache, and dysentery, which is commonly used orally [20][23]. The extract of *O. americanum* was also used for tobacco flavoring, tea, and body fragrance. The leaves and branches were used for insecticides against mosquitoes, bees, flies, and other insects. In Africa, the Swahili tribe utilizes the aerial parts

of the plant for the treatment of high blood pressure and stomach aches [24]. In addition, local people in the Tamil Nadu area use a decoction of the leaves as a medicine for diabetes, constipation, diarrhea, hemorrhoids, and dysentery [25].

O. americanum has several phytochemical components, such as alkaloids, flavonoids, phenolic, tannins, terpenoids, saponin, steroids and glicosides. Some studies reported that saponin, phenolic, and tannins are found in less polar solvent such as ethyl acetate leave extract [24], while glicosides and steroids are commonly found in methanol extract [25]. Moreover, phenolic, flavonoids, saponin, and tannins were found in the aqueous extract of leaves and flowers [26]. The pharmacological activities found in *O. americanum* are antioxidant, antifungal, antimicrobial, anti-insecticide and larvicide, and gastric cytoprotective antiulcer effect [27][28].

2.2. Ocimum basilicum

Ocimum basilicum, commonly called sweet basil, is one of the species of genus *Ocimum* from Asia, Africa, and South America regions [29][30]. *O. basilicum* can live in different climates and ecology, grows in cool humid areas to tropical areas with the temperatures between 6 and 24 °C, and also favors warm conditions [31]. This plant is the species of *Ocimum* which is commercially available in the market [32]. It has six different morphologies, namely true basil with green leaves, small-leaf basil, which belongs to green cultivars with short narrow leaves and grows rounded, lettuce-leaf with broad leaves, purple basil A, which has green leaves with purple flowers and stems, purple basil B, where the leaves, flower, and stems are purple, and purple basil C, which has a similarity to purple basil B and has broad listered leaves [33][34]. *O. basilicum* is 20 to 80 cm tall with glabrous and woody stems, large green leaves, and is broadly elliptical, measuring 2.5 to 5 cm × 1 to 2.5 cm. The flowers are red, pink, or white, with a size of 3 mm, and are arranged in terminal spikes [35].

Traditionally, the fruit of *O. basilicum* was used as folk medicine against inflammation, diarrhea, worm infestation, and eye-related disease [36]. Leaves and flowers of *O. basilicum* were used as tonic and vermifuge, and can also be used as a tea to treat nausea, flatulence, and dysentery. *O. basilicum* contains essential oils that are commonly used to treat colds, seizures, and treatment of wasp stings and snakebites [37]. The polysaccharide component of *O. basilicum* was traditionally used as cancer treatment in China [38][39]. In South Europe, they used *O. basilicum* as Mediterranean food, such as the cuisines of Italian and Greek [40].

O. basilicum contains the main components that are beneficial for health such as calcium, phosphorus, vitamin A, vitamin C, and beta carotene [41]. Phytochemical constituents contained in *O. basilicum* are alkaloids, flavonoids, phenols, saponins, tannins, terpenoids, carbohydrates, cardiac glycosides, cholesterol, glycosides, and phlobatannis [42][43]. Therefore, it has the potential to have anti-inflammatory, antimicrobial, antivirals, anticancer, antifungal, antidiabetic, anti-allergic, analgesic, cardioprotective, and immunomodulatory properties [43][44][45][46]. Then, flavonoids and phenolic compounds gave antioxidant activity [47][48].

2.3. Ocimum gratissimum

O. gratissimum, with the common name of clove basil, is a species of family *Labiate* which grows in tropical region, namely India and West Africa [49][50]. It is 1–3 m tall and has leaves that are 3–4 cm × 1–2 cm [51]. The flowers have several colors, such as yellowish white, greenish purple, hairy, calyx greenish purple, brown seeds, and not slimy [52]. In Africa, eastern, central, and western Kenya, *O. gratissimum* is commonly found in scrub and disturbed highland forests at elevations of 600 to 2400 m above sea level [53].

Traditionally, *O. gratissimum* was used for the treatment of cough, fever, snakebites, mosquito repellent, anemia, inflammation, and diarrhea [53][54]. It has several bioactivities, namely antioxidant, anti-inflammation, antimycotoxicogenic, antibacterial, antifungal, antimalaria, and antiseptic activities [55][56][57][58]. The phytochemical components of *O. gratissimum* are alkaloids, saponins, tannins, phlobatannins, glycosides, phenols, anthraquinones, flavonoids, and terpenoids [59][60].

2.4. Ocimum campechianum

O. campechianum is a plant of the Lamiaceae family group which originates from the tropics of South and Central America. This plant is commonly known as “Albahaca de campo” or “Albahaca silvestre”, used by local people for traditional medicine or culinary purposes [61][62]. This plant has a height of 1 m and contains essential oil components with two types of aromatic leaves, namely glandular trichomes, peltate, and capitate. In addition, *O. campechianum* contains components of flavonoids, polyphenols, and tannins [63][64]. Traditionally, this plant is used as a decoction of leaves, ointments, and for the treatment of fever, cough, bronchitis, diarrhea, dysentery, and hypertension. In addition, *O. campechianum* can also be used as an emmenagogue that helps childbirth [65]. In terms of pharmacological effects, this

plant extract is known to have antifungal, antioxidant, antiradical, antiproliferative, and analgesic activities [62][66][67]. In addition, it also has potential as a natural larvicide and pesticide [68].

2.5. Ocimum sanctum

O. sanctum is a plant from the Lamiaceae family, commonly known as basil or tulsi, which is native to India and is widely distributed as a cultivated plant throughout Southeast Asia [69]. It is known as a sacred plant in India and a symbol of purity. It got the name of “Tulasi” from Tulasi Devi, one of the Lord Krishna’s eternal consorts. Tulasi was a Gopi who was said to have fallen in love with Krishna and was cursed by his wife Radha. He is very similar to Vishnu [70]. In India, it is used for religious plants and important events such as weddings [71]. *O. sanctum* is 30–75 cm tall with an herbaceous shape, and is erect, more-branched, and hairy-soft [70]. It has pointed or blunt leaves, the leaves are oval, and the flowers are tightly coiled with a pale red or dark red color [72].

Traditionally, *O. sanctum* was used for the treatment of diarrhea, chronic fever, malaria, skin disease, bronchitis, dysentery, insect bite, arthritis, and bronchial asthma [73][74]. *O. sanctum* has several bioactivities such as anticancer, antispasmodic, antifertility, antimicrobial, anti-inflammatory, antioxidant, antifungal, analgesic, antidiabetic, cardio protective, adaptogenic, antiemetic, and hepatoprotective [75][76][77][78]. It has several phytochemicals, namely terpenoids, phenolic, flavonoids, glycosides, and propenyl phenols [79]. Moreover, it also contains vitamin C, A, and minerals such as zinc, iron, and calcium [80]. The protein content in *O. sanctum* is 4.2 g, then 0.5 g fat, 25 mg carbohydrates, 287 mg phosphorus, 25 mg calcium, vitamin C per 100 g, and 15.1 mg iron [81].

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