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Review Article

Bioactivity and the Prospect of *Stelechocarpus burahol* as Oral Deodorant

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Abstract

Medicinal plants have long been known to prevent, treat, and improve the health of people around the world including in Indonesia. Medicinal plants are also known as a source of raw materials for medicines and cosmetics. One of the plants that have the prospect to be used as cosmetic ingredients is *Stelechocarpus burahol*. In Indonesia, the fruits of this plant has been used traditionally as a deodorant and deodorant by the family of queens and princesses in the kingdoms of Yogyakarta and Solo. The use of *Stelechocarpus burahol* fruit can scent body odor, including sweat, urine, and feces. This article will review the bioactivity of burahol and the prospects of *Stelechocarpus burahol* as oral deodorant.

Keywords: *Burahol; Stelechocarpus burahol; Bioactivity; Halitosis; Oral Deodorant*

Introduction

Stelechocarpus burahol (Blume) Hook.f and Thomson or burahol is native plants on the island of Java, Indonesia. *Stelechocarpus burahol* plants are also spread in several Southeast Asian countries to the Solomons Islands. In Indonesia, this plant is known by the name of kepel, kecindul, simpol, cindul (jawa), burahol, turalak [1,2].

Stelechocarpus burahol is a tropical plant, grown in hot, humid and wet area in Java. This plant is found at an altitude above sea level 600m. *Stelechocarpus burahol* tree is a large tree, upright to a height of 25m. A trunk diameter of up to 40 cm, dark gray-brown to black, the bark of a typical covered with numerous tubercles thick. The leaves are oval-lanceolate, 12 - 27 cm × 5 - 9 cm, soft pink to red burgundy- when young, green, and dark in color when mature. The flowers are unisexual, green turned white; male flowers grow on old branches, 8 - 16 together, up to 1 cm diameter oval, with flower petals around 7 - 8 mm [2]. Female flowers are cauliflorous on the lower part of the trunk as well as ramiflorous on the main branches, up to 3 cm in diameter with 3 oval-ovate, obtuse sepals and imbricate petals in 2 whorls of three; ovaries many, 6-8 ovular with hairy sessile stigma. The fruits of *Stelechocarpus burahol* grow on the lower part of the trunk on the larger branches. They have a spicy flavor. They are greenish-yellow and oval, 3 - 5 centimeters long, brownish, 5 - 6 cm in diameter, juicy, edible, yellow pulp enclosing 4 - 6 ellipsoid seeds, 3 - 3.5 cm long [1,2]. The tree and fruits of *Stelechocarpus burahol* as shown in figure 1.

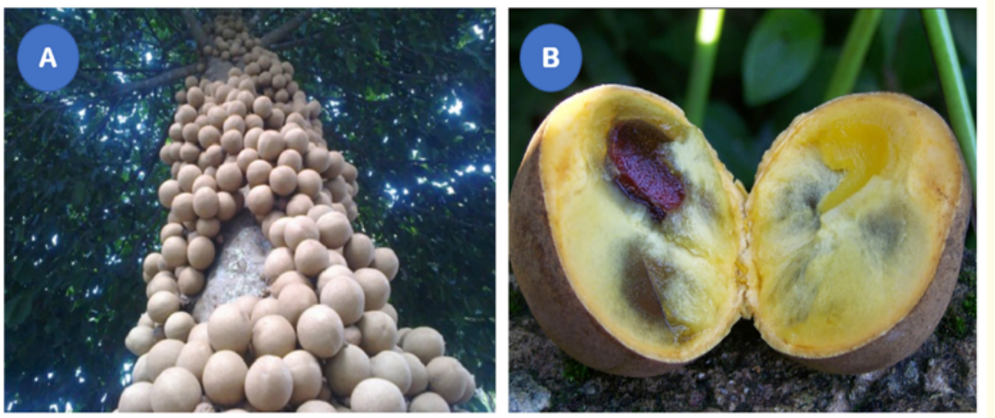

Figure 1: *A. Tree and fruit of burahol. B. Fruit and seed of burahol [3].*

Stelechocarpus burahol plants grow wild in humid forests or planted at several locations around West Java - East Java [4]. In East Java *Stelechocarpus burahol* plants found in Nganjuk, Ngawi, Madiun, Blitar, Malang, Pasuruan and grows wild in Merubetiri National Park in Jember/Banyuwangi [5]. Its natural habitat is growing in secondary forests in Java, especially in Yogyakarta. Based on ecological studies conducted in Purwodadi in 2009 showed that plants grow well at an altitude of 300 meters above sea level, with 20 - 31^{o}C temperature, rainfall of 2018 mm/year, relative humidity 70 - 80%, on a fertile soils with pH 5.8 to 6.7 [6]. Flowering season is from September to October and the fruit can be harvested in April-May [7].

Traditionally this plant has been used as a perfume, especially among women in the royal palace of Yogyakarta. They eat fruits in order to eliminate body odor, scent of breath, and even cause the scent of urine [4,8]. *Stelechocarpus burahol* can also be used for birth control (contraception), laxative urine and prevent inflammation of the kidneys and for the treatment of gout [8]. This article reviews bioactivity of *Stelechocarpus burahol* and its prospect as oral deodorant.

Bioactivity of burahol

Various biomedical studies have been conducted to determine the bioactivity of burahol, such as antihyperuricemia [9], antioxidant [10], inhibitor of cyclooxygenase-2 (COX-2) [11], anticancer [12], anti-inflammatory [13], anti-implantation [14], and to treat halitosis or oral malodor [15-17]. Some of the bioactivities of *Stelechocarpus burahol* are shown in table 1.

No.	Bioactivity	Part of plant	References
1	Anti-hyperuricemic activity	Leaves extract	Purwantiningsih., *et al*. 2010 [9] Purwantiningsih., *et al*. 2011 [18] Hakim., *et al*. 2010 [19] Sunarni., *et al*. 2015 [20] Sunarni., *et al*. 2017 [21]
2	Antioxidant	Leaves extract	Sunarni., *et al*. 2007 [10] Tisnadjaja., *et al*. 2006 [22] Suwandi., *et al*. 2012 [23]
3	Inhibitor of cyclooxygenase-2	Leaves extract	Batubara., *et al*. 2010 [11]
4	Effect of Cytotoxicity	Fruit extract	Sunardi., *et al*. 2003 [12]
5	Anti-implantation	Stem Bark	Sunardi., *et al*. 2010 [24] Suparmi., *et al*. 2015 [25]
6	Xanthine oxidase inhibitor	Leaves extract Leaves fraction	Purwantiningsih., *et al*. 2010 [9] Hakim., *et al*. 2010 [19] Diniatik., *et al*. 2016 [26] Diniatik., *et al*. 2017 [27]

7	Anti- halitosis/oral deodorant	Fruits extract	Darusman., *et al*. 2012 [15] Amin., *et al*. 2017 [16] Mun'im., *et al.* 2017 [17]
8	Prebiotics activity	Fruits extract	Darusman., *et al*. 2012 [15]
9	Hepatoprotective activity	Fruits suspension	Alvernita., 2011 [28]
10	Antimicrobial agents	Fruits sub fraction	Amin., *et al*. 2018 [29]
11	Improve the quality of spermatozoa	Fruits extract	Priastini and Rumiati, 2010 [30]
12	Malodor controlling activity	Lozenges of fruits	Soen Bing., *et al.* 2018 [31]
13	Antibacterial agent	Leaves sub fraction	Indriani., *et al*. 2011 [32]
14	Anti-acne activity	Leaves and fruits extract	Rahminiwati., *et al*. 2010 [33]
15	Antifungal activity	Leaves sub fraction	Anggara., *et al*. 2014 [34]
16	Antiseptic	Fruit extract	Pribadi., *et al*. 2014 [13]

Table 1: *List of bioactivities of Stelechocarpus burahol.*

Extracts of *Stelechocarpus burahol* leaves can lower uric acid levels in plasma of rats and chickens that are hyperuricemia [9]. *Stelechocarpus burahol* (Bl.) Hook. f. and Th. possessed an activity as anti-hyperuricemic agent. The leaves was the main source of the raw material for the herb-drug product [18]. The effect of antihyperurecemia is due to of the precence of flavonoids in the *Stelechocarpus burahol* extracts and antihyperuricemia activity of extracts ethanol of *Stelechocarpus burahol* leaves has better activity than allopurinol [9]. *Stelechocarpus burahol* is also used traditionally to treat gout [19]. Flavonoids of *Stelechocarpus burahol* leaves have antioxidant activity and inhibitor of xanthine oxidase [9,10]. Several studies of antioxidant activity of *Stelechocarpus burahol* plant have been done. Using DPPH (1,1-diphinyl pycril hidrazil) showed that the n-butanol extract of flowers of *Stelechocarpus burahol* has IC_{50} 22.44 ppm) while the ethyl acetate of fruit extract has IC_{50} 12.29 ppm [10,22]. Flavonoids are the main compounds of *Stelechocarpus burahol* which are useful as antioxidants [11].

The cyclooxygenase 2 (COX2) inhibition activity on *Stelechocarpus burahol* leaves obtained from five different regions of Indonesia (Karang Anyar, Nusa Kambangan, and Cilacap, Central Java, and Yogyakarta) shows that water extract and ethanolic extract of leaves and *Stelechocarpus burahol* fruit have a cyclooxygenase 2 (COX2) inhibition activity of about 51%. While the hexane and ethyl acetate extracts of fruits and ethyl acetate of *Stelechocarpus burahol* leaves have only 20% inhibitory activity [11].

Two phenanthrene compounds isolated from stems of *Stelechocarpus burahol*, aromalactam and aristolactam can inhibit the growth of leukemia cells L1210 with IC_{50} values of 0.87 and 0.66 mg/ml respectively [12]. In addition spermatheridine compound (liriodenine), has been isolated from bark of *Stelechocarpus burahol* [14], are highly toxic to *Artemia salina* Leach (Brine Shrimp Lethality Bioassay) with LC_{50} = 0.08 ppm. Liriodenine also been found in nine genus of the family Annonaceae [35].

Stelechocarpus burahol fruit extracts contain alkoloid that can be used to prevent pregnancy [4]. The ethanol extract from fruit of *Stelechocarpus burahol* showed antiimplantation activity in female Wistar rats. The extract is administered orally daily from the diestrus phase to the 7th day of pregnancy. The results showed that the extract of *Stelechocarpus burahol* fruit significantly reduced the number of baby rats. *Stelechocarpus burahol* works through antiimplantation and abortifascient mechanisms. Its antiimplantation activity does not cause teratogenic effects in infant rats [24]. The fruit extract of *Stelechocarpus burahol* can also affect the number, motility and viability of spermatozoa in rabbits [30].

Stelechocarpus burahol showed good activity as a hepatoprotector in mice [28]. The fruit juice from *Stelechocarpus burahol* has anti-inflammatory activity against open wounds in animals and can accelerate wound healing in mice [13]. Previous study showed that *Stelechocarpus burahol* also contains natural steroids [36]. Steroids in bark of *Stelechocarpus burahol* consists three components: 3,5-ergostenol, stigmasterol and beta-sitosterol [37].

Burahol as oral deodorant

Deodorants are substances used to prevent or reduce the body's malodor. The formation of body malodor is mainly caused by excretion of compounds from the sweat glands in the skin and bacterial activity. The smell of the human body, which occurs in the underarm area, the anogenital area, and around the navel [38], is derived from the apocrine sweat glands, which secrete a chemical compound which is then broken down by the skin flora into a compound that causes body odor [39].

The body has two types of sweat glands, the eccrine and apocrine glands. Apocrine glands are present in areas where hair grows, scalp, underarms, and anogenital areas [40]. Some unsaturated fatty acid compounds that cause body odor include E-3-methyl-2-hexenoic acid and 3-hydroxy-3-methyl-hexanoic acid, 3-methyl-3-sulfanyl hexane-1-ol, androstenol (5α-androst-16-en-3α-ol), and steroid androstenone (5α androst-16-en-3-one) [41].

Some factors that affect body odor are caused by several things, such as genetic factors, psychiatric conditions, dietary factors, obesity and clothing [40]. Malodour formed in the human body is caused by biotransformation of various microorganisms from odorless substances into odorous molecules. Generally body odor comes from the axilla, in which the population of microorganisms grows on the secretions of the eccrine, apocrine and sebaceous glands. Some microorganisms involved in body odor include Staphylococcus, Micrococcus, Corynebacterium and Propionibacterium, which produce short and medium chain volatile fatty acids, 16-androsten steroids and thioalkohol [42].

Propionic acid is also present in sweat, which is the result of propionic acid decomposition of amino acids by bacteria Propionibacterium. Isovaleric acid (3-methyl butanoic acid) is a body odor compound as a result of bacterial activity of *Staphylococcus epidermidis* [43]. While the odor of feces and urine can be caused by the activity of digestive microbes that produce volatile nitrogen (ammonia), amine compounds (trimethylamine), compounds of intestinal decomposition products (indole, skatole or 3-methylindole, cresol, phenol, thiol) and sulphide (methyl mercaptan) compounds, by Enterobacteriacee [44].

Halitosis

Essential major compounds of oral malodor or halitosis are volatile sulfur compounds (VSCs), such as hydrogen sulfide, methyl mercaptan, and dimethyl sulfide. Hydrogen sulfide and methyl mercaptan are the most dominant compounds that cause halitosis. These compounds are the result of proteolytic degradation by predominantly anaerobic Gram-negative oral microorganisms of various sulfur-containing substrates in food, saliva, blood, and epithelial. Amino acids present in saliva are substrates that can produce volatile sulfide compounds [45,46].

Various oral microorganisms that often to cause oral malodor are Gram-negative bacterial species include Enterobacteriaceae, *Porphyromonas gingivalis, Porphyromonas endodontalis, Prevotella intermedia, Bacteroides loescheii, Fusobacterium nucleatum, Centipeda periodontii* and *Eikenella corrodens* [47,48]. Since oral malodor mainly caused by protein degradation of bacteria, the halitosis can be overcome by: (i) reduction of the intraoral bacterial load, (ii) reducing the availability of nutrients of microorganisms, (iii) conversion of VSC to non-volatile and (iv) masking malodor [49-52]. The main compounds that caused oral malodor are hydrogen sulphide (H_2S), methyl mercaptan (CH_3SH), and dimethylmercaptan (CH3SSCH3), or compounds such as butyric acid, propionic acid, putrescine, and

cadaverine [53]. These sulfides are produced mainly from amino acid such as cysteine and methionine found in saliva, cervical fluid, gingival and tongue [54,55].

Oral deodorant

One method to reduce body odor is to use deodorant. Deodorant is administered topically serves to inhibit the growth of bacteria that cause body odor. While oral deodorant is a deodorant that is applied by either ingested in the form of food or beverage or of herbal medicinal and can effectively reduce malodors on the body secretions including urine and feces.

The fruits of *Stelechocarpus burahol* have long been used by the princesses of Yogyakarta and Surakarta by eating *Stelechocarpus burahol* fruit to eliminate body odor. *Stelechocarpus burahol* fruit can make body, mouth, and urine smell good [4]. Some studies on the benefits of *Stelechocarpus burahol* fruit as a cosmetic ingredient, especially as deodorant has been widely done. By using the Kitagawa Precision Pump, it has been shown that the extract of *Stelechocarpus burahol* fruits significantly absorbs ammonia (NH3) and methyl mercaptan (CH3SH) in rat feces. In addition, fruit of *Stelechocarpus burahol* can also increase the population of probiotic bacteria Bifidobacter sp. in the gastrointestinal of mice [15]. Previous studies shown that proanthocyanidins, a flavonoid isolated from grape seed extract is effectively able to reduce the ammonia and methyl mercaptan level in animal feces. In addition, oral deodorants are also able to increase the population of Bifidobacterium [44]. Other studies have shown that *Stelechocarpus burahol* fruits have good activity to reduce ammonia in stools in rats by 75.5%, phenol 42.4%, trimethylamine 75% respectively, compared to the control group [56].

In an *in vitro* study of *Stelechocarpus burahol* fruit extracts, showed that ethanol extract from *Stelechocarpus burahol* fruits can absorb methyl mercaptan of 83.31% followed by butanol extract and water extract of 64.56 and 53.74% respectively. While the study in humans with crossover study designs on 20 volunteers for 3 days given 15 mL of oral solution containing *Stelechocarpus burahol* extract per day showed significant activity to eliminate oral malodor compared with placebo [17]. A similar study also showed that fruit extract of *Stelechocarpus burahol* is useful as anti-halitosis [16].

Based on some studies indicate that *Stelechocarpus burahol* fruits have a good prospect to be developed as oral deodorant. This deodorant activity is caused by the ability of *Stelechocarpus burahol* fruits to adsorb the odor-producing compounds. The compounds contained in *Stelechocarpus burahol* extract that can absorb body odor mainly are flavonoids and tannins, especially proanthocyanidins compounds [15,44]. Previous studiy showed that ethyl acetate fraction of *Stelechocarpus burahol* fruit could inhibit the growth of oral bacteria [29].

Conclusion

Stelechocarpus burahol is a plant that is traditionally used for health care, especially as an oral deodorant. Several biomedical studies have shown that plant extracts contain compounds that can reduce levels of ammonia, methylmercaptan, phenolic compounds and inhibit the growth of oral bacteria. Although it still needs to be investigated and developed further, especially with regard to the mechanism of action to eliminate body odor, *Stelechocarpus burahol* has good prospects to be developed as an oral deodorant.

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