

(REVIEW ARTICLE)



## Review of research on the uses and benefits of Ketapang plant (*Terminalia catappa*) extracts in Indonesia

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Magna Scientia Advanced Biology and Pharmacy, 2025, 14(01), 038-044

Publication history: Received on 26 December 2024; revised on 15 February 2025; accepted on 18 February 2025

Article DOI: <https://doi.org/10.30574/msabp.2025.14.1.0020>

### Abstract

A literature study regarding the results of research on the uses and benefits of the ketapang plant (*Terminalia catappa*) in Indonesia has been carried out. Through the Google search engine, it was found that there were 34 articles published in the last 15 years. The revealed uses and benefits of Ketapang plant extracts are: natural dye, anti-corrosion, herbicide, fish growth stimulant, toxicity, cytotoxic, anticancer, anti-hypercholesterolemia, wound healing, insecticide, antioxidant, and antimicrobial. Thus it can be concluded that ketapang is a multi-purpose plant.

**Keywords:** Ketapang; *Terminalia catappa*; Indian almond; Singapore almond

### 1. Introduction

Ketapang is the Indonesian vernacular name for *Terminalia catappa* L, a tree plant that reaches 25–40 m in height. This tree species, also called India almond or Singapore almond, is a perennial plant that is native to the Malaysian Peninsula, Southeast Asia and the Andaman Islands, that is now can be found naturalized across tropical and subtropical America, the West Indies, tropical and temperate Asia, and East and West Africa. This plant has edible fruits and a timber that is useful general-purpose hardwood, and is suitable for furniture manufacture [1] Rojas-Sandoval, 2017

Apart from the wood which is useful for building and furniture purposes, the ketapang or the sea almond plant deserves to be called a very valuable plant because it has many benefits, one of which is an environmentally friendly dye for fabric and textile. [2] Vadwala and Kola, 2017.

Apart from that, this plant is also known to contain many active substances in its leaves, bark, fruit and seeds. Various active substances have been found such as tannins, flavonoids, alkaloids, tannins, amylase, cellulase, lipase, and laccase. The pharmacological properties of the ketapang plant include anti-diabetic, anti-cancerous, antioxidant, anti-HIV reverse transcriptase, hepatoprotective, anti-inflammatory, anti-microbial, anti-hepatitis, hypoglycaemic, antiparasitic and antifungal. [3] Singh et al., 2023

In Indonesia, ketapang plants also receive attention from researchers in various scientific fields such as: biology, chemistry, physics, pharmacy, parasitology, fisheries, agriculture, engineering and marine technology. Here in this article we present the results of research on the benefits of ketapang plants by Indonesian researchers in the last 15 years.

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## 2. Material and methods

### 2.1. Search strategy

By using Google search engine we search online the relevant literature. The database we targeted is not limited to its reputation, but rather the open access nature of the database in question. All open access databases that allow the full text to be downloaded are used in searches including PubMed, Tandfonline, Web of Science, Semantic Scholar, MDPI, JSTOR, Zandy, Zenodo, SCI, and Research Gate. The keyword used was as follows “ketapang” AND “*Terminalia catappa*” AND “India almond”.

### 2.2. Inclusion criteria

The inclusion criteria of the paper are published in a platform that can be accessed via internet in Indonesia. All papers presenting the results of study on the effect and uses of *Terminalia catappa* plant were included in the search. The country areas where the research is conducted and the institution where the researcher is affiliated, type of language used are also not taken into consideration. The year of publication of the work is also not used as a criterion for data compilation in this review. Likewise, the type of language in the article is not used as an acceptance criterion in the search.

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## 3. Results and Discussion

We managed to find at least 34 research articles about the benefits of ketapang plants in Indonesia in the last 15 years. In this 15 year period it is known that in Indonesia the ketapang plant is studied by many researchers from various fields of science. Based on these researches, it is known that there are at least 13 benefits of ketapang plants as follows.

### 3.1. Active substances

Zuhrotun *et al.*(2010) by using thin layer chromatography (TLC) in analyzing the ethanol extract of the stem bark of ketapang found flavonoid, kuinone, saponin, catechin, gallotanin, and steroid/ triterpenoid [4]. Furthermore, by analyzing the ethanol extract content of Ketapang leaves obtained using ultrasonic techniques, Sari *et al.* (2018) found the highest total phenolic content of 4862,353 mg GAE/g [5]. Next, still using ethanol leaf extract, Santi *et al.* (2020) revealed tannin with a concentration up to 98% [6]. Also from leaf extract, Senjaya *et al.* (2023) succeeded in finding that Ketapang plants contain up to 97.5% Pelargonidin 3-O-glucoside [7].

### 3.2. Natural dye

By extracting ketapang leaves with alum mordant and water and ethanol solvent with different concentration (25%, 50%, 75% and 100%) Krisnawati *et al.*(2022) find a dye powder. The direction of the dye color is yellow-green to brown. So that their assumed leaf extract of ketapang can be used for the natural dyes powder on cotton fabric [8].

### 3.3. Anti-corrosion properties

Research in the field of physics has shown that ketapang plant leaf extract can be used as a corrosion inhibitor for iron. Marlianto and Ramadhani (2020) found that tannin extract of ketapang leaves showed efficiency up to 47% in inhibiting corrosion in iron submerged in sea water [9]. Furthermore, also using leaf extract, Salsabila *et al.* (2023) proved that an extract concentration of 1100 ppm could reduce the corrosion of metal immersed in 1M HCl solution with an efficiency of 39.22% [12].

### 3.4. Herbicidal properties

Leaf extract of *Terminalia catappa* revealed to have herbicidal properties because able to affect germination of other plant. In the plant seed of *Mikania micrantha*, the extract with distilled water of 70% was able to prevent the seeds from germinating while the methanol and ethanol extracts of this plant able to inhibit the germination [10]. Furthermore, in *Cayenne pepper* plants, water extract from ketapang leaves was found not to inhibit germination but decreased the vigor index [11].

### 3.5. Fish growth stimulant

Leaf extract of ketapang given to ornamental fish (*Betta sp*) in a pool revealed to enhance survival and increase profile of red blood cells, white blood cells, and hemoglobin of the fish [13]. Boiled water from ketapang leaves mixed with hatching media of cork fish (*Channa striata*) eggs is known to increase the hatchability of the fish eggs [14]. Next, boiled

water from ketapang leaves was also known by Lembang et al. (2023) can increase the absolute length and growth of tilapia (*Oreochromis niloticus*) [15].

### **3.6. Toxicity activity**

By extracting fruit flesh of the ketapang with polar and non-polar solvents, then testing the extract on *Artemia salina* shrimp larvae using the Brine Shrimp Lethality Test (BSLT) method, Widyaningsih et al. (2022) found that the ethyl acetate extract of the fruit flesh of the ketapang was toxic with an LC50 value of 17,171 ppm [16].

### **3.7. Cytotoxic properties**

Cytotoxic properties of ketapang plant were reported by Widaryanti et al. (2016) after analyzed the leaf extract of this plant using MTT Cell Viability Assay. The result showed that chloroform, ethyl acetate and methanol extract of ketapang leaves were notable to reduce cell viability in breast cancer cell line T47D [17].

### **3.8. Anticancer properties**

Sundhani et al. (2024) found that ethanol leaf extract of ketapang plant has anticancer activity in breast (T47D) and cervix (Hela) cancer cell lines. They found this effect by testing the ethanol extract of ketapang leaves combined with Doxorubicin (DOX) against the two cancer cell lines. [18].

### **3.9. Anti-hypercholesterolemia**

Ketapang plant extract was supposed by Waluyo and Wahyuni (2017) to have anti-cholesterol properties. They discovered this properties from experiments on giving ethanol extract of ketapang leaves to lard-induced hypercholesterolemia male mice [19].

### **3.10. Wound healing properties**

Methanol extract of ketapang leaves has properties in healing cut wounds. This benefit was discovered by Ramadhan et al. (2017) through an experiment by giving ketapang leaf extract to mice suffering from cut wounds. Wound healing is accompanied by an increase in collagen fibers in the wound [20].

### **3.11. Insecticide properties**

Redo et al. (2019) examined the effect of administering ethanol extract of ketapang leaves on Instar III larvae of the *Aedes aegypti* mosquito. The result was that ketapang leaf extract had significant larvicidal properties compared to standard larvicide temephos with an LC50 value of 1.563 mg/ml [21]. However, Azmi et al. (2023) by treating *A. aegypti* larvae with leaf extract of ketapang found that the mortality effect of the extract was less than abate [22].

### **3.12. Antioxidant activity**

From stem bark of ketapang plant Fauziah and Syahmani (2011) was succeeded in extracting substance that have antioxidant properties. By using DNPH and hydrogen peroxide scavenging (Ruch method) they found that the ketapang stem bark extract showed antioxidant better than of standard antioxidant (Vitamin E and tocopherol) [23]. Meanwhile, it is known from the leaf extract that young leaf extract has more antioxidant activity than old leaves [24]. When the antioxidant properties of ketapang leaf extract were compared with ginger rhizome extract, the antioxidant properties of ketapang leaves were better [25]. Next, Salimi et al. (2022) using the DPPH technique found that the antioxidant properties of methanol extract of ketapang leaves were 460.37 mg AEAC/g [26].

### **3.13. Antimicrobial properties**

Of the 34 articles we found, 11 of them were about the antimicrobial properties of ketapang plant extracts. The plant parts used, extraction methods, experimental techniques, and research results regarding the antimicrobial properties of ketapang plant extracts are presented in Table 1.

**Table 1** Research results on the antimicrobial properties of the ketapang (*Terminalia catappa*) extract in Indonesia

| Plant part | Preparation  | Experiment   | Results   | Reference                      |
|------------|--|--|---|--------------------------------|
| Stem bark  | Extracted using ethanol and fractioned using n-hexane, chloroform, and ethyl acetate | The extract was tested against <i>Staphylococcus aureus</i> and <i>Candida albicans</i> to evaluate its antimicrobial activity             | Ethyl acetate fraction shows the highest anti-microbial and all fractions have lower anti-microbial than standard antibiotic.                             | Sumintir et al., 2012 [27]     |
| Stem bark  | Maceration using 96% ethanol   | Extract is used to treat bacteria <i>Aeromonas hydrophila</i> and blood cells of the infected carp ( <i>Cyprinus carpio</i> )              | The extract has antibacterial activity induced the total erythrocyte in the <i>A. hydrophila</i> infected fish  | Maftuh, 2018 [28]              |
| Leaves     | Stratified extraction using n-hexane, ethyl acetate and ethanol solvent              | The extract was tested against bacteria isolated from water pool and the gills of Mujair fish ( <i>Oreochromis mossambicus</i> )           | The extract show inhibitory against bacteria cause gills disease in the fish  | Syarmalina and Sari, 2012 [29] |
| Leaves     | Extracted using 95% ethanol  | The extract was tested to evaluate its antibacterial activity  | The extract cause inhibition zone in <i>Staphylococcus aureus</i> and <i>Pseudomonas aeruginosa</i>   | Allyn et al., 2018 [30]        |
| Leaves     | Crude extract of leaves  | The extract was tested against bacteria of <i>Edwardsiella tarda</i> using disc diffusion method   | Ketapang leaf extract show bacterostatic effect against <i>E. tarda</i> bacteria.   | Maryani et al., 2020 [31]      |
| Leaves     | Leaves extracted   | The extract tested in vitro to <i>Vibrio harveyi</i> bacteria to evaluate its minimum inhibitory and minimum bactericidal concentration    | The extract was able to inhibit and kill <i>V. harveyi</i> bacteria a minimum concentration of 1.56% and the minimum bactericidal concentration of 3.12%. | Kharisma et al., 2020 [32]     |
| Leaves     | Extracted with 96% ethanol solvent and formulated into liquid soap                   | The extract was tested against bacteria <i>S.aureus</i> , <i>S. epidermidis</i> , and <i>E. coli</i> to see its inhibition zone MHA media. | The liquid soap has antibacterial activity at a concentration of 1%, 2%, and 3%, with the largest   | Dewi and Mardhiyani, 2021 [33] |
| Leaves     | The ketapang leaves and garlic extracted using ethanol                               | The extract were tested against <i>Pseudomonas aeruginosa</i> bacteria   | Ethanol extract of ketapang leaves and garlic bulbs in single and the combination have antibacterial activity against <i>P. aeruginosa</i> .              | Mesak, 2022 [34]               |
| Leaves     | Red and brown leaves were macerated using 96% ethanol.                               | Antibacterial properties were tested against <i>S. aureus</i> using disc diffusion method in NA media.                                     | Red leaves extract at a concentration of 20% showed a highest inhibition zone up to 13.8 mm.  | Vagestini et al., 2023 [35]    |
| Leaves     | Extracted using ethanol solvent  | Extract was tested against <i>Staphylococcus aureus</i> Methycilin Resistance and <i>Pseudomonas aeruginosa</i> isolates.                  | Ethanol extract of ketapang leaf has antibacterial Gram-positive and Gram-negative bacteria   | Darmawati et al., 2023 [36]    |
| Seeds      | Soxhlet extraction method with a solvent mixture of water and ethanol 96%.           | The extract was tested against <i>E. coli</i> bacteria to evaluate its growth inhibition properties  | The higher the extract, the greater the growth inhibition growth of <i>E. coli</i> bacteria,  | Minata et al., 2023 [37]       |

In principle, the findings of Indonesian researchers are complementary to research results in other countries in the world. That pharmacologically the Ketapang plant extract has properties as antimicrobial, anti-tumor, anthelmintic, anti-diabetic/hypoglycemic, antibacterial, antioxidant, hematological/erythropoiesis enhancer [38], anti-arthritis [39], and anti-aging [40].

Apart from the pharmacological properties, other benefits of ketapang extract revealed by researchers in other countries which are similar to the findings of Indonesian researchers are as a dye for nylon fabric [41], and inhibiting corrosion in stainless steel submerged in acidic media [42].

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#### 4. Conclusion

The ketapang plant (*Terminalia catappa*) is rich in active compounds in every part of its body, starting from the leaves, stem bark, fruit and seeds. This plant extract has been proven to have many properties and benefits for building materials, dyes, anti-corrosion, food ingredients and medicines. Thus it can be concluded that the ketapang plant can be called a multi-purpose plant.

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#### Compliance with ethical standards

##### *Acknowledgments*

All authors would like to thank all peers and colleagues at the Biology Department, the Faculty of Mathematics and Natural Sciences, University of Lampung, for their positive supports.

##### *Disclosure of conflict of interest*

The authors declare no conflict of interest.

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