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by Irnanda Ummi Sofia, Ika Dyah Kumalasari, Noridah Potential Of Active Compounds In Mangroves As Food

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Potential of Active Compounds in Mangroves as Food Preservatives: a Literature Review

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ABSTRACT

Mangroves have an essential role in food and nutrition for the public and coastal communities. This study aimed to obtain a general description of the types of mangrove plants, their content of bioactive compounds, extraction methods, and the potential for development and processing as alternative food sources. This study was a literature review that collected articles from Google Scholar, Semantic Scholar, ScienceDirect, and Hindawi based on relevant articles. The types of mangrove plants whose fruit can be developed as food include *Avicennia marina*, *A. alba*, *A. lanata*, *Bruguiera gymnorhiza*, *Sonneratia alba*, and *Nipah fruticans*. From an economic point of view, mangroves can be used as various processed foods, beverages, and food materials.

Keywords: mangrove, *bioactive compounds, antioxidants*.

INTRODUCTION

Food is an essential human need, and its fulfillment is also part of human rights. Humans have the right to eat food that is safe for consumption. Food safety problems occur all over the world. The World Health Organization (WHO) estimates 70% of the approximately 1.5 billion food-borne diseases (foodborne diseases). As consumers, people must get guaranteed protection from the circulation of unsafe food. This is in line with Law Number 8 of 1999 concerning Consumer Protection Article 4. This condition implies that food safety is an absolute requirement for a food product to be safe for consumption by the public.

Food safety is a science that discusses the preparation, handling, and storage of food or beverages so that they are not contaminated by physical, biological, and chemical substances. The main goal is to prevent food and beverages from being contaminated by foreign substances, both physical, natural, and chemical, to reduce the potential for illness due to food hazards (Surono et al., 2016). According to Government Regulation Number 86 of 2019 on Food Safety, the implementation of food safety is intended so that the state can protect the people from consuming food that is safe for health and mental safety.

An effort to prevent damage to food materials is to control, inhibit, and even reduce the microorganisms present in these food materials by adding preservatives. Microorganism growth control aims to prevent disease and infection, eradicate microorganisms in infected hosts, and prevent spoilage and destruction of materials. Concentrations of preservatives permitted by food regulations are inhibitory rather than lethal to polluting organisms. Food preservatives are classified into natural preservatives obtained from fresh food ingredients or extracted from plants and synthetic preservatives such as formalin (Rahmawati, 2017). Some chemicals are added to food to increase shelf

life to be mass-produced and can also be used to increase consumer appeal in terms of color, taste, and shape.

Mangroves are tropical and subtropical forests that grow around beaches or rivers influenced by tides and are often found in coastal areas protected from waves (Janah et al., 2020). Mangroves have an essential role in estuaries as one of the coastal ecosystems. Mangrove utilization can be classified into two broad categories. First, mangroves serve as buffer zones to protect beaches from abrasion, stabilize sedimentation, and purify polluted coastal water. Second, mangroves provide various products such as wood, fuel, food, and medicine and are also a source of bioactive compounds (Miranti et al., 2018).

Bioactive compounds are compounds contained in the bodies of animals and plants. Phytochemical tests can determine bioactive compounds. This compound increases stamina and the immune system and prevents several diseases, such as cancer, heart disease, stroke, high blood pressure, cataracts, osteoporosis, and gastrointestinal infections. Phytochemical compounds found in plants are alkaloids, flavonoids, quinones, tannins, polyphenols, saponins, steroids, and triterpenoids (Juniarti et al., 2010).

Antioxidants are compounds that can inhibit or prevent the oxidation of substrates that are easily oxidized and used by the public. Antioxidant reserves in the body are limited so that when there is excessive exposure to free radicals, the body requires an external source of antioxidants. Antioxidants are grouped into two categories based on their origin: natural antioxidants and synthetic antioxidants. Natural antioxidants are obtained naturally and become a potential alternative to be developed as a substitute for synthetic antioxidants. Natural antioxidants contain bioactive compounds (Sudirman et al., 2014).

RESEARCH METHOD

The stages of the research method are problem definition, data collection, data analysis, and conclusions. The research methodology can be seen in Figure 1.

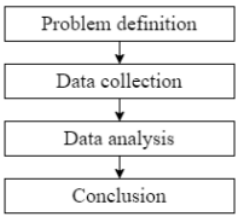

Figure 1. Research methodology

Based on Figure 1, the research stages consist of:

1. Problem Definition

Problem definition is done by studying and analyzing the predetermined topic. The objectives, scope of the study, and conclusion-making methods are selected at this stage.

2. Data Collection

The data collected is from various open access journals based on relevant scientific articles. The articles were obtained from Google Scholar, Semantic Scholar, ScienceDirect, and Hindawi.

3. Data Analysis

The study is a literature review that uses the narrative method to review and analyze previous studies related to the potential of active compounds in mangroves as food preservatives. Keywords used were mangrove, bioactive compounds, antioxidants, and food preservatives.

4. Conclusion

The data obtained from the literature review results were summarized and analyzed qualitatively by describing the results descriptively. Conclusions are drawn from the entire literature studied.

RESULT AND DISCUSSION

1. Types of Mangroves

Based on the search and review of the literature results regarding the types of mangroves that have active compounds in food preservation, four types of mangroves were obtained, namely *Bruguiera gymnorrhiza*, *Rhizophora stylosa*, *Sonneratia alba*, and *Nypa fruticans*. The morphological characteristics and bioactive compounds in the mangroves can be found in Table 1 below.

2. Potential and Benefits of Mangroves in the Food Sector

Bioactive compounds can provide positive physiological effects beyond the essential nutritional value of food ingredients. In general, bioactive compounds are absorbed from the digestive tract into the circulatory system and then carried to their target organs (Rohim et al., 2019).

Antioxidants are compounds that can scavenge free radicals. Free radicals are generated due to several factors, such as smoke, dust, pollution, the habit of consuming fast food that is not balanced between carbohydrates, proteins, and fats. Antioxidant compounds will donate one electron to unstable free radicals so that these free radicals can be neutralized and no longer interfere with body metabolism (Rahmi, 2017).

Atta et al. (2017) state that antioxidants are widely used as raw materials in dietary supplements for health and preventing diseases such as cardiovascular cancer disease. In addition, antioxidants can be used as preservatives for food. Therefore, researchers are trying to explorends natural antioxidants as an alternative to prevent free radicals. One source of biological antioxidant agents is herbal medicine originating from the sea coast, such as mangrove *S. alba*.

Based on the search and review of the literature results regarding the potential of bioactive compounds (antioxidants compounds) in mangroves as food preservatives, five relevant kinds of literature were found for further study. The results of the literature review are presented in Table 2 below. The reference selection parameter in this literature review is the antioxidant activity based on the IC_{50} value in mangroves.

Table 1. The morphological characteristics and bioactive compounds in the mangroves

Types of mangroves	Morphological characteristics	Bioactive compounds
Bruguiera gymnorrhiza	Leaves skinned, green on the top layer and yellowish-green on the underside with black spots (some are not). The fruit is spirally circular, transversely circular, 2 – 2.5 cm long. The hypocotyl is straight, blunt, and dark green to purplish (Handayani, 2018).	Steroids, triterpenoids, saponins, flavonoids, alkaloids, and tannins. (Hastarini et al., 2014)
Rhizophora stylosa	The fruit is a pear-shaped fruit with a length of 2.5-4 cm; brown contains one fertile seed. The hypocotyl is cylindrical slightly nodule. The cotyledons are yellow-green when ripe. The hypocotyl has a 20-35 cm length and 1.5-2 cm diameter (Handayani, 2018).	Phenolic compounds benzophenone, flavonoids, phenolic acid, dihydroflavonol tannins, caffeic acid, vanillic acid, p-hydroxybenzoic acid, fatty acids, alkaloids, coumarins, phenols and polyphenols, quinones, resins, saponins, phytosterols, xanthoprotins, pigments, and sugars. (Ridlo et al., 2019)
Sonneratia alba	*S. alba* has a characteristic grayish-brown stem, stalks, and twigs tend to be dense with a height of 2-10 m. *S. alba* has many respiratory roots and protrudes above the ground, and is conical in shape, reaching 25 cm in height (Handayani, 2018).	Alkaloids, phenols, tannins, saponins and flavonoids. (Handayani, 2018)
Nypa fruticans	The leaves are like the arrangement of coconut leaves. The length of the bunch/leaf hilt is 4 – 9 m. There are 100-120 pinak leaves in each leaf bunch, shiny green on the top surface and powdery on the bottom. The size around 60 – 130 x 5 – 8 cm. The fruit is round, brown, stiff, and fibrous. Each fruit contains an egg-shaped seed. The diameter of the fruit head is up to 45 cm, and the seed diameter is around 4-5 cm (Handayani, 2018).	Both the fruit and leaves of Nipah contain several secondary metabolites, including flavonoids, phenols, triterpenoids, tannins, and saponins (Khairi et al., 2020)

Table 2. Summary of selected articles

Literature	Materials	IC_{50} Value
Miranti *et al*., 2018	Coffee and tea product from the fruit *Rhizophora stylosa*	Coffee mangrove = 5,25 µg/ml Tea mangrove = 4,13 µg/ml
Thuoc *et al*., 2018	Raw crabapple mangrove (*Sonneratia caseolaris* L.) fruits	J1 = 41,8 mg/ml J2 = 40 mg/ml J3 = 7,3 mg/ml
Cruz *et al*., 2015	The leaf, root, and bark of *Rhizophora mangle*	Leaf = 0,15 mg/mL Root = 0,21 mg/mL Bark = 0,24 mg/mL
Sudirman *et al*., 2014	The large-leafed mangrove (*Bruguiera gymnorrhiza*) fruit	Old fruit = 13,46 ppm Young fruit = 81,60 ppm

Anggraini et al. (2018) showed that *B. gymnorrhiza* leaf powder was positive for steroids, flavonoids, saponins, tannins, and phenol hydroquinone. Tannins can inhibit microbial activity. Tannins are found in many vascular plants, such as angiosperms. Tannins can be used as antimicrobial agents. This is because tannins can inhibit peptidoglycan synthesis so that bacteria cannot replicate (Widjajanti et al., 2015).

Asides from that, the steroid tends to be a source of antibacterial because it can inhibit bacterial growth by decreasing cell function; this causes the bacterial cell to burst (lysis). According to Rosyidah et al. (2010), steroid compounds are readily soluble in lipids. This property makes it easier for these compounds to penetrate bacterial cell walls in gram-positive and gram-negative bacterial cells. Flavonoids function as inhibitors of bacterial growth and metabolism by damaging the cytoplasmic membrane and denaturing cell proteins. This is because flavonoids have antimicrobial effects that form complexes with extracellular and soluble proteins and bacterial cell walls (Ardananurdin et al., 2004).

3. Extraction Method and Identification of Active Compounds in Mangrove

Extraction is the process of separating materials from the mixture by using a suitable solvent. The extraction process was stopped when equilibrium was reached between the concentration of the compound in the solvent and the concentration in the plant cells. Furthermore, according to Mukhriani (2016), several methods can be used to extract compounds, namely maceration, percolation, soxhletation, and distillation. The extraction method most often used to extract various types of mangroves is maceration.

Maceration is a quite simple extraction method without a heating system known as cold extraction. The sample and solvent do not undergo a heating process so that they can be used on not heat-resistant compounds, but this method takes a long time. According to the research conducted by Mile et al. (2021) uses, the maceration method because it is one of the easy and simple extraction methods. Based on the phytochemical testing of the mangrove fruit *Rhizophora mucronata* qualitatively, there are several bioactive compounds such as flavonoids, saponins, tannins, triterpenoids, and steroids, as well as hydroquinone phenol compounds. Kumari et al. (2015) stated that the compounds contained in the leaf extract of Rhizophora mucronata are saponins, flavonoids, anthracene, and tannins. These compounds can be derived from the cotyledons in the extract of mangrove fruit so the community can use it as an ingredient in traditional medicine and as an antioxidant preparation.

4. Application of Active Compounds in Mangrove for Food

Mangroves in Indonesia are dominated by *Rhizophora*, *Avicennia*, *Bruguiera*, and *Sonneratia* species (Rahim & Baderan, 2017). This mangrove is also the type most widely used by the community to be processed into food sources and used as a plant food source. (Rosulva et al., 2022). Based on Handayani (2018), several trials have been carried out on mangrove fruit from *Avicennia alba*, *Sonneratia alba*, *Bruguiera gymnorhiza*, *Rhizophora mucronate,* and *Nipah fructican* plants. Especially for fruit from *A. alba*, *B. gymnorhiza*, and *R. mucronata*, product diversification is directed to semi-finished raw materials such as flour. This is because this form of flour has several advantages, such as it is not bulky (takes up space in storage and distribution), being more durable (because its water content is relatively low), can be used as raw material for various forms of processed food (e.g., crackers, noodles, cakes, bread and so on) and has a higher economic value.

Mangrove fruit processing is currently limited to producing regional specialties traditionally processed by local communities. There are several variants of cakes made from processed fruit and mangrove flour from the four types of mangrove fruit, namely chips, crackers, various variants of cakes, snacks, candy, dodol, pudding, jelly, and jam.

Making different processed foods produces cakes with delicious and nutritious flavors and has added value. The use of mangrove fruit itself has been widely carried out in Indonesia and helps improve the economy of coastal communities from the added value of processed mangrove fruit (Rosulva et al., 2022).

Furthermore, according to Handayani (2018), the development of *Sonneratia alba* fruit, in this case, it can be used as a variety of food and beverage products with the advantages of high vitamin C content, such as jams, jams, dodol, and candy, due to the relatively high content of pectin, fruit juice, syrup and so on. The various products produced have a distinctive taste and aroma from the *Sonneratia* fruit. For the development of the fruit, *Nipa frukticans* is more appropriately directed to processing its sap, for example, for ant sugar, rock sugar, liquid sugar, and nipa legen. In addition to morphology, the fruit is small (the size of a salak Bali), the fibers are stiff, and the flesh is thin and easy to hard when experiencing delays processing, relative nipa sap tapping process younger. As for processing *Nipah* fruit that can be developed, for example, sweets, cocktails, dawet, etc.

CONCLUSION

Mangroves have various bioactive compounds that can act as food preservatives. The content of these compounds makes mangroves as functional food materials. The use of mangroves itself is quite diverse, ranging from being processed into flour, syrup, sweeteners, and others.

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