Natural Antibacterial and Its Use

Sandriana J Nendissa¹, Meta Mahendradatta², Zainal³, Februadi Bastian⁴

¹Student at the Doctoral Program of Agricultural Science of Agriculture Faculty, Hasanuddin University - Makasar
²,³,⁴Agriculture Faculty. Hassanudian University – Makassar

sandriananendissa@gmail.com¹, meta_mahedradatta@yahoo.com², zainal_burhan@yahoo.com³, februadi@gmail.com⁴

Abstract
In today's era, the use of natural antimicrobials such as plant extracts to preserve food processed products has received much attention from researchers. This is related to the increasing public awareness of synthetic chemical preservatives. Various types of plants have been stated to produce extracts that are effective in inhibiting the growth of bacteria that destroy food processed products, such as atung seed ethyl acetate extract (Parinarium glaberrimum Hassk) Bacillus cereus, Bacillus subtilis, Staphylococcus aereus, while pathogenic bacteria are Escherechia coli, Salmonella enteriditis; Guava leaf extract has a high tannin compound capable of suppressing the development of Aeromonas hydrophila bacteria in Gurame fish (Osphonomus gouramy Lacepede) with a concentration of 250 ppm - 3250 ppm with a diameter of the inhibition zone ranging from 6.5 - 11.5 mm. The most effective solvent to extract antimicrobial compounds from the bark of Saccoglottis gabonensis is methanol; Rastina, 2015; Rahmawati & Bintari, 2014, extracting methanol from the bark of the bay plant with a concentration of 80% has the ability to inhibit the growth of Escherchia coli bacteria followed by ethanol from Bligo Fruit extract (B. hispida Thunb) which has good inhibitory power at a concentration of 10% against Staphylococcus typhimurium bacteria. 70% ethanol. Among the various types of solvents, ethanol and methanol solvents are most often used for the extraction of antibacterial compounds from plant materials.

1. Introduction
Food is one of the most important basic human needs so it must be safe, proper, and of good quality. Food that is suitable or not consumed cannot be separated from the presence or absence of destructive bacteria and food pathogens. These bacteria can be contained in food due to contamination of food during processing and storage. To improve quality and extend the shelf life of food processed products, people sometimes use additive preservatives to preserve these products. This is what makes public concern about the side effects of using chemical additives as food preservatives to increase today, because these compounds are feared to cause various diseases such as cancer, kidney disorders and others, if consumed continuously in long period of time. Therefore, the use of natural antibacterial as food preservatives derived from plant extracts needs to be developed.

Antibacterial are substances that can interfere with and inhibit the growth or kill bacteria by metabolizing harmful bacteria. The mechanism of action of antibacterial compounds is to inhibit cell wall synthesis, inhibit the integrity of bacterial cell wall permeability, inhibit enzyme action and inhibit the synthesis of nucleic acids and proteins (Dwidjoseputro, 2010).
Natural antibacterial as food preservatives are derived from plant extracts whose antibacterial power against pathogenic bacteria and food spoilers has been studied, among others; Temulawak Rhizome (Deasywati, 2011), Lime Leaf (Yuliani R et al, 2011), Flacourtia Inermis Fruit (George. S et al, 2011), Avocado Leaves (Liberty et al, 2012), Cinnamon Leaves (Angelica, N., 2013), Starfruit Leaves (Insani M et al, 2016), Guava Leaves (Anggraeni et al, 2017), Sweet Orange Skin Extract (Citrus sinensis), Ardhia D.R Dewi, 2019).

Traditionally, the community has used plant ingredients to preserve food. Plant materials such as atung, turmeric, garlic, galangal, lemongrass and others are used by the community to preserve foods such as jerky and fish. After researching these materials, it turns out that they contain various bioactive compounds that can inhibit bacterial growth.

Exploration of natural materials that have a role as food preservatives is needed today, to reduce the use of synthetic chemicals. Various obstacles were encountered in utilizing natural ingredients as food preservatives, such as low effectiveness, unstable processing conditions, sometimes unwelcome aroma, and less practicality. The preparation of food preservatives sourced from natural ingredients in the form of extracts is expected to overcome this problem. The purpose of this paper is to discuss the natural antibacterial properties of plant species and their use as food preservatives, antibacterial compounds and extraction methods for these active ingredients.

2. Method

The research method used is in the form of literature study from national and international journals as a library in writing. With this method, it can summarize the current state of understanding about related topics so that they can be presented in the form of articles.

3. Result And Discussion

Natural Antibacterial

Natural antibacterials are antibacterials that come from plants or the bacteria themselves. Some examples of natural antibacterial properties that can be used as food preservatives include: wood smoke containing phenol and formaldehyde, essential oils from spices, nisin produced by Lactococcus lactis (Adams and Moss, 2000), and plant extracts such as Allium tuberosum (chives), Cinnamomum cassia (cinnamon) (Mau, et al., 2001).

Nowadays, the use of natural antibacterial such as extracts from plants to preserve food has received much attention from researchers. The use of lime peel waste can preserve meatballs, wet noodles and tofu researched by Ardia Deasy (2017) said that 90 minutes of soaking can suppress total bacteria for 4 days of storage at room temperature and according to Mehmood et al. (2015) stated that sweet orange peel waste also has natural compounds that have the potential to be used as a natural preservative because it has antibacterial properties that can inhibit Escherichia coli, Staphylococcus aureus, Salmonella thypii.

Flacourtia Inermis Fruit which has phenol and tannin compounds to preserve food ingredients as well as inhibit the bacteria Serratia marcescens, Escherichia coli, Pseudomonas aeruginosa, Staphylococcus aureus and Klebsiella pneumoniae (George.S et al, 2011). Wuluh starfruit leaf extract with a concentration of 10% can affect the shelf life of catfish fillets at low temperature storage and can be accepted up to the 9th day (Insani M et al, 2016). Temulawak contains alkaloid compounds, quinones and terpenoids which can inhibit the activity of Staphylococcus aureus, Streptococcus and Bacillus bacteria in chicken meat and fish (Widiastuti, 2016). Tohyeng et al. (2018) also said that the curcuminoids in turmeric extract can control the growth of pathogenic bacteria such as Escherichia coli and Salmonellai in tofu storage for 72 hours at room temperature. Rosidah and Afiziz W, M (2012) reported that guava leaf extract has high tannin compounds capable of suppressing the development of Aeromonas hydrophila bacteria in Gurame fish (Osphonemus gouramy Lacepedia) with a concentration of 250 ppm - 3250 ppm, the diameter of the inhibition zone ranges from 6.5 - 11.5 m
Types of Plants as Antibacterial Potential
Various types of plants have been stated as potential antibacterial that can produce extracts that are effective at inhibiting the growth of food contaminant bacteria, among others; The results of research by Prasad and Seenaya (2000) show that clove oil extract contains eugenol at a concentration of 93-95% of the total volatile compound content and as an antibacterial compound in inhibiting the growth of halophilic bacteria in salted fish products with a concentration of 0.1%. Leuscnher and Zamparini (2002) said that adding 1% of garlic extract to mayonnaise can reduce 10 times the number of live S. enterica serovar Enteritidis. Ethylacetate extract of atung seeds (Parinarium glaberrimum Hassk) showed strong antibacterial activity against six strains of food spoilage bacteria, namely Bacillus cereus, Bacillus subtilis, Staphylococcus aereus, while pathogenic bacteria, namely Escherechia coli, Salmonella enteridis (Moniharapon E and Hashinaga F, 2004). Leuscnher and Zamparini (2002) said that with the addition of 1% extract of the nutmeg (M. fragrans Houtt) pulp extract, it has terpenoid compounds at a concentration of 8% and 10% can inhibit the growth of Staphylococcus aureus and Escherichia. Coli (Nurjanah, 2014). Rinaldy et al (2017) showed the ability of the essential oil content of kaffir lime, which is a flavonoid compound in inhibiting or preventing the growth of Staphylococcus aureus bacteria by damaging cell walls so that bacteria are inhibited. The ethanol extract of Curcuma domestica V. rhizome has a high inhibitory power against the growth of S. aureus bacteria with a concentration of 80% w/v (Putri Ramadhani et al, 2017).

Preservatives from Natural Plant Materials
Various types of plants contain natural preservatives or substances that are antimicrobial and antioxidant. Antimicrobial compounds are biological compounds that can inhibit bacterial growth and activity.
Some parts of the plant contain compounds that are antibacterial. These compounds are produced biologically by plants. These compounds can come from plant parts such as leaves, flowers, fruits, seeds, roots, rhizomes and fruit peels and bark (Table 1
Table 1. Natural Ingredients Which Have Antibacterial Compounds.

| No | Ingredients                        | Section | Effect               |
|----|------------------------------------|---------|----------------------|
| 1  | Andalehat (Chrysophyllum roxburghii G. Don) | Fruit   | Antibacterial        |
| 2  | Andaliman (Zanthoxylum acanthopodium D.C) | Fruit   | Antibacterial        |
| 3  | Antarasa (Litsea cubeba)            | Seed    | Antibacterial        |
| 4  | Atung (Parinarium glaberrimum Hsk.)  | Seed    | Antibacterial, Anti-air |
| 5  | Garlic (Allium sativum L.)          | Tubers  | -                    |
| 6  | Star fruit (Averrhoa carambola L.)   | Leaf    | Antibacterial        |
| 7  | Fragrant sandalwood (Santalum album L.) | Wood   | Anti-air             |
| 8  | Pomegranate (Punica granatum L.)    | Fruit, sap | Antibacterial   |
| 9  | Guava (Psidium guajaya L.)          | Leaf    | Antibacterial        |
| 10 | Cashew (Anacardium occidentale L)   | Leaf, Seed | Antibacterial   |
| 11 | Cantilever (Michelia champaca L.)   | -       | Antibacterial        |
| 12 | Kecombrang                          | flower  | Antibacterial        |
| 13 | Kedawung (Parkia roxburghii G. Don) | Bark    | Antibacterial        |
| 14 | Moringa (Horinga oleifera Lamk.)    | Root    | Antibacterial        |
| 15 | Cubeb (Piper cubeba L.)             | Fruit   | Antibacterial        |
| 16 | Chitosan, the result of deacetylation of chitin found in shrimp shells | - | Antibacterial, Anti-air |
| 17 | Kumis kucing (Orthosiphon stamineus Benth.) | Leaf    | Antibacterial        |
| 18 | Turmeric (Curcuma domestica Val.)   | Root    | Antibacterial, Anti-air |
| 19 | Galangal (Languas galanga Stunz.)    | Root    | Antibacterial, Anti-air |
| 20 | Galangal malacca (Alpinia galanga L) | Root    | Antibacterial, Anti-air |
| 21 | Mobe (Ficus sp.)                    | Fruit   | Antibacterial        |
| 22 | Bay leaf (Syzigium polyanthum (Wight) Walp) | Leaf   | Antibacterial        |
| 23 | Betel (Piper betle L.)              | Leaf    | Antibacterial, Anti-air |
| 24 | Suji (Pleomale angustifolia M.E Brown) | Leaf    | Antibacterial        |
| 25 | Temu giring (Disoxyzlum ammoroideis Mig) | Root, Leaf   | Anti-air, Antibacterial |
| 26 | Curcuma (Curcuma xanthorrhiza)      | Root    | Antibacterial, Anti-air |

Antibacterial compounds derived from plants are mostly known to be plant secondary metabolites, especially alkaloids, phenolics and terpenoids (Cowan 1999). Most of the secondary metabolites are bio-synthesized from many primary metabolites such as amino acids, acetyl co-A, mevalonic acid, and intermediate metabolites. In addition, several compounds that are naturally derived from plants are phytoalexin, organic acids, essential oils (essential oils), phenolic and several groups of plant pigments or similar compounds (Nychas and Tassou, 2000).

**Antibacterial Compounds**

One type of food that contains antibacterial compounds as a natural food preservative is spices.

Spices according to Farrell (1990) are defined as ingredients that are dried, and are plants or parts of the plant either in whole or in pieces, and function more as a flavoring than to increase the nutritional value of a food, and can be in the form of bark, shoots, tubers, flowers, fruit, leaves, rhizomes, roots or seeds of plants. Antimicrobial sources of these spices include rhizomes (ginger, turmeric, galangal), tubers (garlic and shallots), seeds (cumin, pepper, cloves, picung), leaves (salam and betel), fruit (andaliman, Antarasa, red chilies, nutmeg, and sotul), flowers (kecombrang), and bark (cinnamon, mesoei wood, and kedawung).

Most of the antimicrobial compounds derived from plants are known to be secondary metabolites of plants, especially the phenolic and terpenoids in essential oils. According to Herbert (1995), most secondary metabolites are bio-synthesized from many primary metabolites such as from amino acids, acetyl co-A, mevalonic acid, and intermediate metabolites. Some compounds that are natural
antimicrobials come from plants including phytolexins, organic acids, essential oils (essential), phenolic, and several groups of plant pigments or similar compounds (Nychas and Tassou, 1999).

Oleoresin is a chemical group found in plants and is quite complex in its compounds (Rismunandar, 1988). Oleoresin consists of essential oils, soluble organic resins, and other ingredients found in spices and non-volatile fatty acids (Farrell 1990).

According to Ketaren (1987), essential oils mainly consist of volatile chemical compounds (volatiles), including the acyclic hydrocarbons and isocyclic hydrocarbons and hydrocarbon derivatives that have bind oxygen. Some compounds contain nitrogen and sulfur. Essential oils have advantages, including hygiene, consistent aroma quality, no color effect on products, enzyme and tannin free, and stable storage. Essential oil fractions are the most common antimicrobial compounds found in plants obtained from plant material through steam distillation and / or by cold treatment and vacuum distillation (Farrell, 1990).

The compounds in these essential oils can be classified into 4 major groups which predominantly determine the properties of essential oils, namely terpenoids, straight-chain compounds, do not contain branch chains, benzene derivatives, and various other compounds. Apart from the compounds found in essential oils, there are also other compounds that have antimicrobial activity such as alkaloid and phenolic compounds

a. Terpenoids compound
Terpenoids include a large number of plant compounds and are known to be one of the main compounds in plants that make up essential oils. Essential oils are secondary metabolites that are rich in compounds with an isoprene structure and are present in the form of terpenes, triterpenes, tetraterpenes, hemiterpenes, and sesquiterpenes. This substance distinctive fragrance, fragrance, or odor in many plants (Harborne, 1996). According to Conner (1993), terpenoid compounds that have antimicrobial activity include borneol, cineol, pinene, camphor, and camphor.

b. Alkaloids Compound
Alkaloids are the largest group of plant secondary metabolites. According to Harborne (1996) alkaloids are sometimes toxic to humans and have many prominent physiological activities so that they are widely used in the field of medicine. All alkaloids contain at least 1 nitrogen atom. Most of the alkaloids are formed from amino acids such as lysine, ornithine, phenylalanine, tyrosine, and tryptophan. Several other types are aromatic compounds such as colchicines which contain a base group as a side chain group.

c. Phenolic Compound
According to Gould (1995) phenolic compounds are substances that have aromatic rings with one or more hydroxyl and alkyl groups. Phenolic compounds are grouped into three, including (1) simple phenols (vanillin, gingerol, shogao, gualakol, and eugenol) and phenolic acids (p-creso 3-ethylphenol, hydroquinone, gallic acid, and syringe), (2) derivatives hydroxycinamic acid (p-coumarin, caffeine, and ferulic), and (3) flavonoids (anthocyanins, flavonoids, flavanones, flavanols, and tannins). Flavonoids are the largest group of phenolic compounds. Most of the phenolic compounds and essential oils and especially coumarin, a flavonoid found in medicinal plants, herbal plants and spices, have antimicrobial functions.

PLANT ANTIBACTERIAL EXTRACTION
Voigt (1995) states, in the extraction process, the amount and type of compound that enters the solvent is largely determined by the type of solvent used. The process of extracting plant material includes two phases, namely the rinsing phase and the extraction phase. In the rinsing phase, the solvent rinses the components of the cell contents that have been broken in the previous crushing process. In the extraction phase, at first there is swelling of the cell wall and the loosening of the cellulose framework of
the cell wall so that the pores of the cell wall become widened so that the solvent can freely enter the cell. The contents of the cell are then dissolved in the solvent according to the level of solubility and then diffuse out due to the force caused by differences in the concentration of dissolved materials inside and outside the cell.

Table 2 shows the types of solvents that are often used to extract various types of antibacterial compounds in plant material. According to Cowan (1999), ethanol and methanol are the solvents most often used to extract antimicrobial compounds from plants, because these compounds are generally aromatic and saturated organic compounds.

| Antimicrobial compound | Air | Ethanol | Methanol | Chloroform | Dichloromethane | Ether | Aseton |
|------------------------|-----|---------|----------|------------|-----------------|-------|--------|
| Polyphenol             | ✓   | ✓       |          | ✓          |                 |       |        |
| Tannin                 | ✓   | ✓       |          | ✓          |                 |       |        |
| Anthocyanin            | ✓   |         | ✓        |            |                 |       |        |
| Flavones               |     | ✓       |          | ✓          |                 |       |        |
| Flavonol               |     | ✓       |          |            |                 |       |        |
| Terpenoid              | ✓   | ✓       | ✓        | ✓          | ✓               | ✓     | ✓      |
| Polypeptides           | ✓   |         |          |            |                 |       |        |
| Alkaloid               | ✓   |         |          |            |                 | ✓     |        |
| Koumarin               |     |         |          |            |                 | ✓     |        |

Sumber: Cowan (1999)

The results of Mehrabian's (2001) study showed that methanol and ethanol extracts from tea leaves had stronger antimicrobial power compared to water, acetone and chloroform extracts against Staphylococcus aureus, Streptococcus lactis, Lactobacillus plantarum and Candida albicans. The results of the research by Sedigheh (2001) also showed that the methanol extract of Spartium junceum was more effective than its water extract against gram-positive Staphylococcus and gram-negative bacteria Pseudomonas aeruginosa and Proteus vulgaris.

Likewise, the research results of Faparusi and Bassir (1973) showed that the most effective solvent to extract antimicrobial compounds from the bark of Saccoglottis gabonensis is methanol; Rastina, 2015; Rahmawati & Bintari, 2014, extracting methanol from the bark of the bay plant with a concentration of 80% has the ability to inhibit the growth of Escherchia coli bacteria followed by ethanol with the active compounds in the extract are polyphenol compounds.

Several other researchers who use ethanol as a solvent to extract plant antimicrobial components include: Hong, et al. (2001), to extract Rhus javanica; Erdem and Lmez (2004), to extract bee propolis; and Machado, et al. (2002), to extract the skin of Punica granatum fruit; while Bashari (2001) used methanol to extract the stems, roots and leaves of Vinca major. Mubarak F et al, (2018) said that the ethanol concentration of the Bligo fruit extract (B. hispida Thunb) had good inhibition at a concentration of 10% against Staphylococcus typhimurium bacteria was 70% ethanol.

4. Conclusion

Natural antibacterials from various types of plant extracts that have been discussed above, can inhibit the growth of food-destroying bacteria such as Bacillus cereus, Bacillus subtilis, Staphylococcus aureus, and pathogenic bacteria Escherchia coli, Salmonella using 80% methanol and 70% ethanol as solvent, so they can be useful as natural preservatives to improve quality and extend the shelf life.
References

[1] Hong, M., J. Kim, S. Koh, I. Kim And S. Kang. 2001. Development Of Plant- Derived Antimicrobial Agents To Control Food Spoiling Microorganisms. www.ansorp.org Nopember, 26, 2004

[2] Insani M, Liviaiwyty E, Rostini I, 2016. Penggunaan Ekstrak Daun Belimbing Wuluh Terhadap Masa Simpan Filet Patin Berdasarkan Karakteristik Organoleptik. Jurnal Perikanan dan Kelautan. Vol 7 (2). ISSN 20880 – 3137.

[3] Ketaren, S. 1987. Minyak Atsiri Jilid 1. UI Press, Jakarta

[4] Leuschner, R.G.K. dan Zamparini, J. 2002. Effects of Spices on Growth and Survival of Escherichia coli 0157 and Salmonella enterica serovar Enteritidis in Broth Model Systems and Mayonnaise. Journal Food Control 13: 399–404.

[5] Liberty Malangngi, Meiske Sangi, Jessy Paendon, 2012. Penentuan Kandungan Tanin Dan Uji Aktivitas Antioksidan Ekstrak Biji Buah Alpukat (Persea Americana Mill.). Jurnal MiPa Unsrat Online 1(1) 5-10

[6] Mau, J.L., C.P. Chen and P.C. Hsieh. 2001. Antimicrobial Effect of Extracts from Chinese Chive, Cinnamon, and corni fructus. J. Agric. Food Chem., 49: 183-188

[7] Machado, T. D. B., I. C. R. Leal, A. C. F. Amaral, K. R. N. D. Santhos, M. G. D. Silva And R. M.

[8] Kuster. 2002. Antimicrobial Ellagittanin Of Punica Granatum Fruits. J. Braz. Chem. Soc.,13 (5): 606-610

[9] Mehmood B, Dar KK, AliS, Awan UA, Nayyer AQ, Ghous T, Andleeb S. 2015. Short Communication: Invitro Assessment of Antioxidant, Antibacteria and Phytochemical Analysis of Peel of Citrus sinensis. Pak J Pham Sci 28 : 231-239

[10] Mehrabian, S. 2001. Detecting the Antimicrobial Effect of Tea Leaves (Hypericum) on Mouth Microflora. www.ansorp.org. Nopember, 26, 2004.

[11] Moniharapon E dan Hashinaga F, 2004. Antimicrobial Activity of Atung (Parinarium glaberrimum

[12] Prasad, M.M. dan Seenayya, G. 2000. Efect of Spices on The Growth of Red Halophilic CocciIsolated from Salt Cured Fish and Solar Salt. Food Research International. 33: 793-798.

[13] Restina, Sudarwanto, M., dan Wientarsih, I. 2015. Antibacterial Activity of Ethanol Extract of Curry Leaf (Murraya koenigii) on Staphylococcus aureus, Escherichia coli, and Pseudomonas Sp. Jurnal Kedokteran Hewan, 9(2): 185-188.

[14] Rahmawati & Bintari, 2014. Studi Aktivitas Antibakteri Sari Daun Binahong (Anredera cordifolia) terhadap Pertumbuhan Bakteri Secara In Vitro. Jurnal Kesehatan Andalas.2017; 6(3)

[15] Sedigheh, M. 2001 Antimicrobial Activity Of Ajuga Chamaecistus, Ajuga Austro-Iranica And Spartium Junceum. www.ansorp.org. November, 26, 2004

[16] Syamsir E. 2007. Pengawet Alami Pengganti Formalin: Adakah? [Internet]. [diunduh 2012 JanTersedia pada http/elvira_itp.staff.ipb.ac.id/.../ pengawet-aldi-pengganti-formalin-adakah.
[23] Yuliani Ratna, Peni Indrayudha, Septi Sriandita Rahmi, 2011. Aktivitas Antibakteri Minyak Atsiri Daun Jeruk Purut (Citrus Hystrix) Terhadap Staphylococcus Aureus Dan Escherichia Coli. Jurnal PHARMACON, Vol. 12, No. 2. 50-54.