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Endemic Plants on Karimunjawa Island as an Environmental Conservation Effort

Abdul Malik*

[1]Department of Environmental Engineering, Faculty of Science and Technology, UIN Walisongo Semarang

Abstract

The study of endemic plants in the Karimunjawa Island area is an important concern in plant conservation efforts in protecting the surrounding environment. Endemic plants are unique and native plants that are found in an area and do not exist in other areas because of their small population. The research method used is Systematic Literature Review (SLR). SLR is a research method whose aim is to conduct ongoing and regularly updated systematic reviews, incorporating new, relevant evidence as it becomes available. The result there are three types of typical plants found in the Karimunjawa Islands, namely Dewadaru (*Fragraea elliptica*), Kalimasada (*Cordia subcordata*) and Setigi (*Pemphis acidula*). Dewadaru belongs to the Potalieae tribe. Potalieae is a homogeneous taxon that includes in general Fagraea, Anthocleista and Potalia. Water extract from Dewadaru fruit has been proven to be effective as a natural preservative for tofu, which contains alkaloids, flavonoids, phenolics, saponins and steroids. Kalimasada (*Cordia subcordata*) belongs to the family (Boraginaceae) in the form of wood that is strong and durable, so it is good for use as building materials and household appliances. *Cordia subcordata* contains alkaloids, flavonoids, carbohydrates, glycosides, tannins, terpenoids. While Setigi (*Pemphis acidula*) is used as an ornamental plant (bonsai) with high economic value. *Pemphis acidula* can be used as a bioindicator of a mangrove area that is still beautiful because it is classified as a pure standing mangrove type. The ethanol extract of pandemor leaf simplicia (*Pemphis acidula*) contains a class of flavonoids, saponins and tannins.

Keywords: Endemic; Plants, Karimunjawa; *Cordia subcordata; Eugenia uniflora; Pemphis acidula*

Introduction

Indonesia is a unitary state in the form of an archipelago, consisting of around 17,500 large islands and small islands and has a long coastline of around 95,181 km (Kusmana & Hikmat, 2015). The major islands include Sumatra, Java, Kalimantan, Sulawesi, Nusa Tenggara, Maluku and Papua. Ninety-two small islands of which are the outermost small islands (Kusumo, 2010). Indonesia is a tropical country, located between the continents of Asia and the continent of Australia and between the Pacific and Indonesian oceans so it has high rainfall (Setiawan, 2022). Indonesia is also known as a country that has a wealth of natural resources and high megabiodiversity (Nurhidayati et al., 2009) (Setyawan, 2015), has 90 types of ecosystems both on land and in the ocean and there are 15 types of extensive natural forests (Fauzia et al. al., 2020). The high megabiodiversity is directly proportional to the diversity of flora and fauna in Indonesia. Countries with mega-

*Corresponding Author: Abdul Malik, Department of Environmental Engineering, Faculty of Science and Technology, UIN Walisongo Semarang

biodiversity are inhabited by at least 2/3 of all non-fish vertebrate species and 3/4 of all higher plant species (Setyawan, 2015).

Indonesia is currently experiencing a level of endangerment and extinction of flora and fauna species due to various factors such as deforestation, increasing earth and sea temperatures, and erratic weather anomalies. At present, 240 plant species are declared rare and 36 tree species are declared endangered and around 58 plant species are protected (Kusmana & Hikmat, 2015). According to the Red List of the International Union for Conservation of Nature (IUCN) in 2020 there are more than 128,918 species of which 35,765 (28%) are in the endangered category (IUCN), 2020). In addition, the increasing number of human population growth has resulted in increased levels of consumption of natural resources and has become the main anthropogenic cause of habitat loss for biodiversity (Setyawan, 2015).

Plant species that are scattered in the territory of Indonesia come from Malesiana and have about 25% of the world's plant species (Kusmana & Hikmat, 2015). Natural forest landscapes in Indonesia are spread from the western tip of Sabang to the eastern tip of Merauke with a variety of animal and plant species (Fauzia et al., 2020). Flora is a type of plant that grows in a certain area and forms a habitus (Kusmana & Hikmat, 2015). Plants that grow in certain habitus are unique and endemic and their distribution in certain areas. Endemic plants are unique and rare (Saleh & Hartana, 2017). Endemic forest plant species decreased in abundance (72.0% of forest species) and were detected at fewer census points in 2008 (56.0%) (Maas et al., 2009). The decline in endemic species in the forest is due to the conversion of forest functions to settlements, monoculture forests, and mining and oil exploration.

Karimunjawa is an archipelago consisting of a collection of small islands that have a variety of plant species and have endemic plants (Hutabarat et al., 2021). Karimunjawa is an archipelago located in the Java Sea, approximately 83 km northwest of the coast of Jepara. This archipelago has been designated as a National Park since 1988 with an area of 11,1625 ha Based on the Decree of the Minister of Forestry No. 161/Menhut/1988 (Larashati, 2010); (Ariyati et al., 2007). Ecosystems in Karimunjawa include terrestrial and aquatic vegetation ecosystems, namely lowland rain forest, mangrove forest, coastal forest and seaweed/seagrass beds (Abdullah et al., 2010). Meanwhile, the topography of Karimunjawa consists of undulating lowlands with an altitude of 65–506 m above sea level (Larashati, 2010). Administratively, Karimunjawa is a sub-district of Jepara Regency which is located in the north of Java Island. Karimunjawa has several large islands namely Karimunjawa Island, Kemujan Island, Menjangan Besar Island, Menjangan Kecil Island, Parang Island, and Mosquito Island (Ariyati et al., 2007).

Karimunjawa offers ecotourism of nature and sea and extraordinary landscapes. The concept of ecotourism is to link nature and sea tourism trips that have a vision and mission of conservation and love for the environment (Muniah, 2016). Karimunjawa has a large mangrove forest area on Kemojan Island. There are 39 species of mangrove plants belonging to 25 families. The mangrove species found included *Excoecaria agallocha, Ceriops tagal, Rhizophora stylosa, Lumnitzera racemosa, Scyphiphora hydrophyllacea, Rhizophora*

apiculata, and Rhizophora mucronate (Kuswadi et al., 2021).

In addition to mangroves, the condition of the coral reefs is also very good for underwater tourism. Based on monitoring results (Suryanti et al., 2011) in the Sambangan Island area of Karimunjawa the percentage of coral cover at a depth of 3 meters was 70.42% and at a depth of 10 meters was 66.55%. Meanwhile according to (Sulisyati et al., 2013). There are 15 families, 41 genera and 104 species of coral. The percentage of hard coral cover is in the medium to very good category. The distribution of the number of coral species found in Karimunjawa waters ranges from 20–33 genera, the highest genera being found in Tengah Island, Kecil Island, Krakal Kecil Island and Kumbang Island, while the lowest is found in Kemujan Island, and Menyawakan Island (Yusuf, 2013). The seagrass ecosystem is also a biological wealth in Karimunjawa as a supporting ecosystem for waters and coral reefs. In the coastal area of Karimunjawa, 8 species of seagrass were found, namely *E. acoroides, C. rotundata, C. serrulata, T. hemprichii, H. minor, H. uninervis, H. ovalis and S. isoetifolium*. The density of T. hemprichii seagrass has a total of 450 ind/m2 individuals and a cover percentage of 35.78%. Meanwhile, C. rotundata seagrass had a total of 1204 ind/m^2 individuals and a cover percentage of 65.68%.

The natural landscape of the Karimunjawa island landscape and underwater scenery are the main icons of ecotourism in Karimunjawa. With an abundance of natural resources, it should be put to good use without destroying it so that all of our children and grandchildren can still see and help preserve it.

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Ecosystems in Karimunjawa include terrestrial and aquatic vegetation ecosystems, namely lowland rain forests, mangrove forests, coastal forests and sea grass/seagrass beds. (Abdullah et al., 2010). Meanwhile, the topography of Karimunjawa consists of undulating lowlands with an altitude of 65–506 m above sea level (Larashati, 2010). In the coastal area the community structure of mangrove

vegetation in the Karimunjawa archipelago consists of 7 types of mangroves including *Avicennia marina, Rhizophora apiculata, Rhizophora stylosa, Ceriops decandra, Ceriops tagal, Lumnitzera racemosa and Excoecaria agallocha* (Ulyah et al., 2022). Types of mangroves on Kemujan Karimunajwa Island include *Excoecaria agallocha, Ceriops tagal, Rhizophora stylosa, Lumnitzera racemosa, Scyphiphora hydrophyllacea, Rhizophora apiculata,* and *Rhizophora mucronate* (Kuswadi et al., 2021). In forest areas along the south west and north sides such as the Nyamplungan Block, Jatikerep, Bukit Love, Dukuh Pancoran including lowland rain forest, with a mixture of primary and secondary forests marked by a mixture of small and medium trees such as (*Chionanthus ramiflorus, Garcinia celebica, Glochidion arborescens , Ficus spp., Syzygium spp*.), and a few large trees (*Buchanania arborescens, Sandoricum koetjape, Myristica spp., Litsea spp*.) (Hutabarat et al., 2021). While the types of herbs that are often found include *Tacca spp., Hoya spp., orchids, suplir* and *ferns*. Mangrove cover is high so it has large carbon stores. Karimunjawa National Park has a carbon store of 182.4 tonnes (91.2 tonnes C) with the largest carbon stored in the trunk. (Cahyaningrum & Hartoko, 2014).

Karimunjawa also has plants that are useful as herbal or medicinal plants. According to (Abdullah et al., 2010) in the Nyamplungan Karimunjawa area there are 13 types of plants that have the potential to be used as medicine namely; *Anacardium occidentale, Sandoricum koetjape, Ficus variegate, Vitex pubescens, Leucaena leucocephala, Tectona grandis, Buchanania arborescens, Ardisia humilis, Rhodamnia cinereal, Mangifera indica, Garcinia celebica, and Liquidambar styraciflua*. On a seed exploration expedition in Karimunjawa by (Hutabarat et al., 2021) twenty seven (27) seed collections were found consisting of 15 families, 25 genera and 27 species. The Fabaceae family has the most fruit (6 species), then the Myrtaceae (5 species), Rubiaceae (2 species) and Meliaceae (2 species). Habitat (clay) with total organic matter content ranging from 32.41% – 85.65% greatly influences the composition and growth of mangroves.

According to (Nurhidayati et al., 2009) found 39 species of plants used by the people of Karimunjawa consisting of 21 species of wild plants and 18 species of cultivated plants. Some plant species that grow in the yard are bananas (*Musa paradisiaca L*) and crops. Plants that are often found in the garden are cashew (*Anacardium occidentale L.*), guava (*Psidium guajava*), rice (*Oryza sativa*) and coconut (*Cocos nucifera*). Plants developed as food ingredients in Karimunjawa namely Gondorio (*Bourea macrophylla*), Manggisan (*Calophylum soulatri*), Rice (*Oryza sativa*), Cashew (*Anacardium occidentale*), Mango (*Mangifera indica*), Papaya (*Carica papaya*), Coconut (*Cocos nucifera*), Sweet Potatoes (*Ipomoea batatas*), Grapes (*Vitis vinifera*), Sentul (*Sandoricum koetjape*), Bananas (*Musa paradisiaca*), Jackfruit (*Artocarpus integra*), Jengkol (*Pithecolobium ellipticum*), Cloves (*Eugenia aromatica)* Oranges (*Citrus spec*), Langsep (*Dysoxylum ramiflorum*), and Cassava (*Manihot utilissima*).

Meanwhile, the people of Karimunjawa also use plants as building materials, namely Gondorio (*Bouea macrophylla*), Manggisan (*Calophylum soulatri*), Jambon (*Vitex copasus*), Dewadaru (*Fragraea elliptica*), Coconut (*Cocos nucifera*), Nyamplungan/Bintangur (*Calophyllum inophyllum*), Sentul. (*Sandoricum koetjape*), Lempeni (*Ardisia humilis*), Jackfruit (*Artocarpus integra*), Cigarettes (*Melastoma afline*), Teak (*Tectona grandis*), Laban (*Vitex*

pubescens), and Kliko (*Phylanthus boxifolius*). Aside from being a building material, there are plants that are used as handicrafts and furniture materials that have a high selling value. These plants are Dewadaru (*Fragraea elliptica*), Kalimasada (Cordia subcordata), Setigi (*Pemphis acidula*), Jambon (*Vitex copasus*), Kapasan (*Crypteronia paniculate*), Jackfruit (*Artocarpus integra*), Guava and (*Psidium guajava*) (Abdullah et al., 2010), (Nurhidayati et al., 2009),

There are several hard plants that are used as handicrafts and become typical souvenirs from Karimunjawa. These include Kalimasada (*Cordia subcordata*) and Setigi (*Pemphis acidula*) plants. The people of Karimunjawa use the Dewadaru (*Fragraea elliptica*), Kalimasada (*Cordia subcordata*), and Setigi (*Pemphis acidula*) plants to make bonsai, bracelets, beads, sticks, prayer beads, cigars, rings, ladle and agate. So that these plants become typical plants from Karimunjawa which are used as souvenirs for visitors who come to Karimunjawa. Meanwhile according to (Sudarmin et al., 2017) The Dewadaru, Kalimasada, and Setigi plants are local specialties and rare. The Karimunjawa National Park Agency assesses that there are typical Karimunjawa flora, namely Dewadaru (*Fragrarea fragrans*) and Kalimosodo (*Cordia subcordata*) whose populations have begun to decline because they are widely used as raw materials for the craft industry by the community (Karimunjawa, 2011) (Muniah, 2016).

Based on the belief of the Karimunjawa people that the dewadaru wood which is located at the gate of the Sunan Nyamplungan Tomb there are two very large trees and the people know them as "god wood" (Sudarmin et al., 2017). Dewadaru wood is believed to have sacred properties, that is, whoever keeps the wood at home will avoid the threat of thieves or bad people. The advantage of dewadaru wood is that it does not float or sink. The Dewadaru, Kalimasada, and Setigi plants which are considered unique by the people of Karimunjawa actually have what benefits, advantages and advantages, so that they become distinctive and unique icons and only exist in Karimunjawa. Therefore it is important to study these plant species.

Research Methods

The research method used is Systematic Literature Review (SLR). SLR is a research method that aims to discover and synthesize comprehensive research that addresses specific questions, using an organized, transparent, and replicable procedure at every step in the process (Ariati, 2018). Meanwhile according to (Elliott et al., 2017) SLR is a systematic review that is continuously and regularly updated, incorporate new, relevant evidence as it becomes available.

Research Results and Discussion

Based on the results of interviews with several communities and community leaders as well as from literature reviews that there are 3 plants that are unique and unique from Karimunjawa and are believed to have magical powers and powers for those who have them such as the Dewadaru plant (*Fragraea elliptica*), Kalimasada (*Cordia subcordata*), and Setigi (*Pemphis acidula*).

Dewadaru (Fragraea elliptica)

The Dewadaru plant or also known as Dewandaru is a typical plant in Karimunjawa. According to (Punt, 1978). Dewadaru belongs to the Potalieae tribe. Potalieae is a homogeneous taxon that

includes in general Fagraea, Anthocleista and Potalia. Fagraea has about 35 species across Southeast Asia, tropical Australia and the Southwest Pacific. The genus Fagraea was revised by Leenhouts (1963) when Leeuwenberg (1961) had studied Anthocleista and Potalia.

On the results of phylogenetic research (Sugumaran & Wong, 2012) that Fagraea s.l. based on the DNA sequence results, there are Fagraea and Racemosae species, two others (*Elliptica* and *Gigantea clades*). Fagraea s.l. morphologically and phylogenetically distinct to be considered a single genus. So there are differences with those in Kalimantan. Whereas (Wong, 2012) himself identified that the Fagraea spread across Java was identified with the name Fagraea elliptica Roxb., the naming of which was a bit problematic and dubious. The naming *Fagraea elliptica Roxb* is first used in Hortus Bengalensis of Roxburgh (1814) without description, and then only briefly described in Roxburgh (1824) (*Flora Indica ed. wall.* 2: 32), highlighting "terminal corymbs" in (Wong, 2012).

Picture 1
Morfologi daun Dewadaru di Karimunjawa (Fragraea elliptica) (Nurhidayati et al., 2009)

Dewadaru plants live in the lowlands (Muniah, 2016) and used as raw material for making wooden crafts so that the population in Karimunjawa is decreasing (Hutabarat et al., 2021). Dewadaru tree at picture 1 is known as "god wood". According to the people's belief that Dewandaru wood has sacred properties, that is, whoever keeps the wood at home will avoid the threat of thieves or bad people. (Sudarmin et al., 2017). The advantage of dewadaru wood is that it does not float or sink. The name Dewadaru was also enshrined as Dewadaru Airport in Karimunjawa which became air access from outside Karimunjawa Island. (Karimunjawa, 2011).

According to the Purwodadi Botanical Garden Conservation Center - LIPI, the Dewandaru plant found on Mount Kawi is Eugenia uniflora L. (Renjana, 2020). Dewandaru plant (Eugenia uniflora L.) contains secondary metabolites with antibacterial properties which have the potential as biobactericidal. Dewadaru leaf

extract has antibacterial activity against R. solanacearum bacteria in inhibiting wilt disease. The effective concentrations of dewadaru leaf extract were 20% and 40% with each average diameter of the inhibition zone of 2.13+0.08 cm and 2.15+0.10 cm and each effectiveness of inhibiting the growth of R. solanacearum bacteria 66.77+4.26% and 67.18+1.01% (Wahyu Nugraheni & Ratnasari, 2021). While the histopathological picture of the liver of mice induced by carbon tetrachloride and given ethyl acetate extract of Dewandaru fruit can reduce fatty degeneration by reducing fat vacuoles in the cytoplasm of liver cells (Santoso & Yuda, 2016). Dewandaru contains these essential oils, namely β-ocimen, benzofuran, cariophilen, germacren and biclogermakren and has strong antibacterial activity against the gram-positive bacteria *Staphylococcus epidermidis*. The essential oil is then made into a deodorant with the characteristics of being able to inhibit the growth of S. epidermidis bacteria with an inhibition zone diameter of 8.15 mm, pH 5 (Rusmiati & Nursa'adah, 2017). Water extract of E. uniflora L. fruit, proven effective for use as a natural preservative for tofu, which contains alkaloids, flavonoids, phenolics, saponins and steroids (Tria et al., 2018).

Kalimasada (Cordia subcordata)

The Kalimasada tree or also called Kalimosodo is a typical flora of Karimunjawa (*Cordia subcordata*) whose population has begun to decline because it is widely used as a raw material for the woodcraft industry by the community (Karimunjawa, 2011). The handicrafts are used as souvenirs for tourists visiting the Karimunjawa islands (Nurhidayati et al., 2009). Kalimasada (*Cordia subcordata*) is a plant that has strong and durable wood so it is good for use as building materials and household equipment and is found in many coastal forest vegetation. Kalimasada can be found along the road in Nyamplungan Karimunjawa Village.

Cordia subcordata is a family: (Boraginaceae), is a medium tree that can reach 12 m in height. Skin color is gray, peeling and grooved. The shape of the leaves is alternate and the stem is half the length of the blade, the tip is blunt to a short tapering. Flowers are bright orange and odorless (Gandhimathi & Kumar, 2009). The flowers and fruit bear fruit all year round. The seeds are resistant to water content with high salinity. So that it can grow in sandy or muddy substrates and can live in puddles or when there is a lack of water. Usually grows near the coast (Allen & Family, 1993). Cordia subcordata is hardwood so that local people use it for handicrafts or household furniture such as plates, ladle, silk, or other tools. Meanwhile, the fruit is easily picked by hand or waiting for the fruit to fall from the tree. How to propagate *Cordia subcordata* by growing the seeds in a planting medium, requires irrigation and full sun. If it reaches a height of 1 m the seeds can be moved or planted in another location (Allen & Family, 1993). *Cordia subcordata* can naturally survive and reproduce in coastal areas and islands with the help of songbird pollination. (Wang et al., 2020).

Leaves of *Cordia subcordata Lam*. in picture 2a used in traditional medicine because it can treat liver infections, cirrhosis of the liver and inflammation of the lymph nodes (Gandhimathi, 2021). Cordia subcordata Lam. contains alkaloids, flavonoids, carbohydrates, glycosides, tannins, terpeniods but not found saponins and steroids. Terpenoid compounds protect lipids, blood and body fluids from free radicals such as superoxide, peroxide and hydroxyl radicals. Terpenoids can prevent

the occurrence of cancer in many tissues including breast, colon, stomach, prostate, pancreas, liver and skin. In addition, Flavonoids are also reported to have antioxidant activity (Gandhimathi & Kumar, 2009)(Gandhimathi & Kumar, 2009).

According to research results (Gandhimathi & Kumar, 2009) who looked at the antioxidant activity of the ethanol extract of Cordia subcordata Lam. in rats with carbon tetrachloride (CCl_4) which causes erythrocyte damage. Administration of *Cordia subcordata Lam* ethanol extract. simultaneously (200 and 400 mg/kg body weight/day i.p) with carbon tetrachloride (1ml/kg body weight) in rats for two days alternately for two weeks. The ethanol extract of *Cordia subcordata Lam*. can inhibit lipid peroxidation in plasma and maintain the activity of antioxidant enzymes.

Setigi (Pemphis acidula)

Pemphis acidula is a herbaceous plant, with a height of between 4-10 meters and has irregular branches. Skin color ranging from gray to brown. *Pemphis acidula* is used as an ornamental plant (bonsai) with high economic value. Its existence is in the lowlands and because it is widely used by the community as building materials and handicrafts.

Pempis acidula on Sepanjang Island is used as stick material, pine shrimp (*Casuarina equisetifolia*) is made into bonsai, it is still found growing on the beach (Rugayah et al., 2010). Phempis acidula which is used as an ornamental bonsai plant has quite high economic value so it has the potential to be utilized by the community (Idrus et al., 2023). Setigi (*Pemphis acidula*) can be used as a bioindicator of a mangrove area that is still beautiful because it is classified as a pure standing mangrove species in Gili Sulat, East Lombok. *Pempis acidula* can be used as a traditional medicine, the stem bark is used as a thrush medicine by the people of Pari Island (Hardjito & Harianja, 2007). According to (AP et al., 2022) Pandemor plant (*Pemphis acidula*) is one of the medicinal plants that can be used as a concoction to treat broken bones, pain and aches by the people in the Biak Island region. The ethanol extract of pandemor leaf simplicia (*Pemphis acidula*) from Biak Island and its surroundings contains a class of flavonoids, saponins and tannins. Flavanoids are important chemical compounds in secondary metabolite components that have a polyphenolic structure. Flavonoids have the benefit of protecting cell structures, increasing the effectiveness of vitamin C, anti-inflammation, preventing bone loss and as antibiotics. Saponins are a group of glycosides found in higher plants where the structure contains triterpenes or steroid aglycones with one or more sugar chains. Meanwhile, tannins are a group of polyphenolic compounds that will react with proteins or various other organic compounds including amino acids and alkaloids. The benefits of tannins for plants themselves are protective components against attacks by destructive organisms as well as regulators of plant metabolic processes. Tannins are also widely used in the pharmaceutical, cosmetic and adhesive industries (AP et al., 2022). Stem bark extract from setigi contains antibacterial ingredients that can inhibit the growth of gram-positive S. aureus and gram-negative E. coli and V. carchariae bacteria. (Hardjito & Harianja, 2007). Setigi leaf extract can also be used as an ideal environmentally friendly drug for mosquito larvae control (Samidurai, 2012). Pemphis acidula contains methanol, benzene and acetone extracts determined by the disc diffusion method for pathogenic bacteria namely, S. *aureus, E. coli, P.*

aeruginosa, M. luteus and R. rhodochrous (Samidurai, 2012).

Phempis acidula as a source for future genetic studies that can characterize the chloroplast genome. Its chloroplast genome is 160,054bp in size, with a large single-copy region (LSC) of 89,785 bp, a small single-copy region (SSC) of 18,883 bp, separated by two inverted repeat (IR) regions of 25,693bp. Phylogenetic analysis shows a close relationship between *Phempis acidula* and *Punica granatum*, both of which are members of the Lythraceae family (Jian & Ren, 2019). *Pemphis acidula* is classified as an environmental bioindicator because the presence of setigi is always found on sandy substrates in mangrove forest areas (Idrus et al., 2023). Mangrove vegetation plays an important role in preserving coastal ecosystems physically, ecologically and economically for coastal communities and fishermen.

Picture 2
Morphology of (a) Kalimasada and (b) Setigi leaves in Karimunjawa Island (Nurhidayati et al., 2009)

Conclusion

Endemic plants on Pulau Panjang have their own charm in terms of economic utilization with handicraft products for tourists. The Dewadaru plant (*Fragraea elliptica*) is believed to have magical powers because it comes from (gods). Kalimasada plants (*Cordia subcordata*) are widely used as building materials and handicrafts, while Setigi plants (*Pemphis acidula*) have high economic value as ornamental plants. These three plants are endemic commodities originally from Karimunjawa Island but on the other hand these plants are conservation trees to preserve the environment.

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