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SYNTHESIS OF SEAWEED NANOPARTICLES: POTENTIAL AND APPLICATION

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ABSTRACT

Synthesis of seaweed nanoparticles has been an interest because of its very large potential and can be applied in various fields. Biosynthesis of nanoparticles using seaweed is considered as a green technology because it does not involve hazardous chemicals. Manufacture of nanoparticles made from seaweed as a substitute chemicals indirectly help to reduce the environmental damage caused by organic chemicals. Directly seaweed also had a role in protecting the environment from carbon pollution through C 2 reduction process. C 2 absorption capability through the process of photosynthesis to make seaweed a double role as an economic resource for the community and the global environment as a controller. This review will provide a description of the potential and application for seaweed nanoparticles synthesis, which is the biosynthesis of silver nanoparticle, cellulose nanoparticle as synthetic fiber replacement and seaweed nanoparticle as an antioxidant. In the future, seaweed nanoparticles need to be further developed so that it can be useful in various fields.

Keywords: Biosynthesis, Nanoparticles, Seaweed

INTRODUCTION

Nanotechnology is currently growing rapidly in its application in industry, science and technology for the purpose of making new materials at the nanoscale level. According to Ahmad *et al.,* (2003) nanotechnology was understood as the study of the characterization and manipulation of biological and microbiological materials smaller than 100 nanometers, as well as a unique phenomenon and a new functional characteristic that will arise.

Biosynthetic methods using plant extracts had now become an alternative and simpler method in the manufacture of nanoparticles compared to using chemical and physical methods (Mani e/ a/., 2014). Marine biological material that has great potential for nanoscience and nanotechnology one of which is seaweed. Synthesis of nanoparticles using seaweed has been an interest because of its potential to synthesize nanoparticles of different size, shape and morphology.

The phycologist from various parts of the world in doing research today are no longer just focused on the issue of morphology, phytology, physiology and other things seaweed in detail, but also begin to do research on an ongoing basis on various aspects related to the use of algae (Sharma, 1992), one of which is the application of nanotechnology, which will allow the emergence of new discoveries that not just add value to the seaweed, and even created a new product made from seaweed.

METHODS

This is descriptive research. In this research, data and information collected from literature study. To enrich information and analysis qualification also required secondary data, obtained from the relevant institutions.

RESULTS AND DISCUSSION

Wide diversity seaweed have a variety of benefits. The following will be described applications in detail of seaweed nanoparticle synthesis in the field of industry, science and technology, namely:

1. Seaweed as Silver Nanoparticles Biosynthesis

The application of metal nanoparticles undergo rapid development of applications in the field of catalysis, biosensors, electronics and optics. Among the precious metals that are effective for development as nanoparticles, namely Ag, Pt, Au, and Pd.

Silver nanoparticles are nanoparticles that are often used in the industry. Silver nanoparticles that are incorporated into the polymer textiles can kill bacteria in quick time (Haryono and Harmami, 2010).

The process of silver nanoparticles biosynthesis by using biological agents tend to be more secure and environmentally friendly than the use of inorganic chemicals. Biosynthesis of nanoparticles with seaweed extract is currently undergoing development (Leela & Vivekanandan, 2008). Research conducted by Mani *et al.,* (2014) examined the antibacterial activity of silver nanoparticles synthesis from *Sargassum polyphyllum* resulting the time required by seaweed to reduce Ag^+ ions completely was faster than bacteria and fungi which took between 24 to 124 hours.

The working principle of seaweed in forming the silver nanoparticles is its ability to reduce silver nanoparticles $AgNO_3$ into Ag (0) (Kumar and Yadav, 2009). There are several assumptions of compounds involved in the reduction process of $AgNO_3$. Manju *ct al.,* (2009) suspected that compounds in seaweed like carotenoids and chlorophyll were the main component responsible for the reduction of silver ions and stabilize the nanoparticles. In addition, Kumar *et al.,* (2010) also reported that reductase was a factor involved in the biosynthesis and stabilization of nanoparticles.

Manufacture of nanoparticles made from seaweed as a substitute chemical indirectly help to reduce the environmental damage caused by organic chemicals. Directly seaweed also had a role in protecting the environment from carbon pollution through CO_2 reduction process. CO_2 absorption capability through the process of photosynthesis to make seaweed a double role as an economic resource for the community and the global environment as a controller. The development of an ever-increasing role of seaweed made in controlling the global environment cannot be ignored. IPCC data that was written by Muraoka, (2004) explained that the ocean is able to absorb up to 2 billion tons of carbon dioxide per year. Measurement data of carbon uptake in the waters, indicating that the production of algae contained 3.5 tons 2.7 tons of carbon (Sinha, 2008). Japan's Environment Ministry has reported that the Japanese waters by seaweed in it (Sarggassum, Ecklonia, Seagrass, Laminaria) is able to absorb up to 2.7 million tonnes CO_2/ year including the results of cultivation (Muraoka, 2004).

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2. Seaweed as Cellulose Nanoparticles Substitute of Synthetic Fibers

Textile products are products that have high value commodities, as raw materials of clothing which are basic human needs. The tendency of today's modern era is the manufacture of textiles into the advanced technologies industry. Textile industrialization impact on environmental pollution which eventually lead to the consideration of textile manufacture efforts that is environmentally friendly.

Development of synthetic fiber technology is rapidly increasing, so it is possible to perform the technique of mixing (mixing fibers) on the composition of the yarn structure (natural and synthetic fibers) to be made of fabric that has special properties (Jantas and Gorna, 2006).

Table 1. Crude Fiber Content Some Type Seaweed (Yunizal, 2004)

Seaweed Species	Crude Fiber (%)
Kappaphycus alvarezzi (Doty)	7,08
Sargassum sp.	28,39
Turbinaria sp.	16,38
Gracilaria sp.	8,92

Cotton fabrics is one type of natural fibers (natural fibers) that is derived from plants that is used as raw materials of textile industries or other. The main composition of fiber chemically is cellulose. One of the aquatic commodities that contain high cellulose is seaweed. *Gracilaria verucosa* seaweed contains cellulose which is quite high so it is efficient if applied (AK Siddhanta *et al.,* 2009). Crude fiber content of seaweed can be seen in Table 1.

Cotton fabrics is usually very susceptible to bacterial growth because it is able to retain water or moisture (Haryono and Harmami, 2010). The use of antibiotics and chemicals are commonly used in minimizing microbial growth in cotton fabrics. In addition to the high cellulose content, seaweed or kelp also has antimicrobial activity that is environmentally friendly and biodegradable (Jantas and Gorna, 2006). Therefore, the application of nanoparticles seaweed in cotton fabrics can be used as a substitute of antibiotics and chemicals that are not environmentally friendly.

3. Nanoparticles Seaweed as Antioxidant

Application of nanotechnology in the pharmaceutical field tends to increase, because of its superiority in improving the bioavailability of the active compounds, controlling the release of active compounds and improve sensory properties. In the nano size, the active compound particles are more easily absorbed by the intestinal wall thereby increasing its bioavailability. The absorption of the active compound increases because of rising particle solubility as a result of larger particles surface area. In nano-size, particles also have a longer residence time for adsorbed in the mucosal lining of the intestine.

Marine life that has potential as natural antioxidants one of which is seaweed, which contains bioactive compounds such as carotenoids, phenolic compounds and their derivatives, sulfate polysaccharides, and vitamins (Hermanus *et al.,* 2013). Research conducted by Shanab (2007) tested the antioxidant activity of some seaweed from the Suez Canal, Egypt that were *Sargassum dentifolium* with IC_{50} value of 82.17 ppm, *Laurencia papillosa* with IC_{50} 77.45 ppm, and *Jania corniculata* with IC_{50} 81.44 ppm.

Research by Nedovic *et al.* (2011) stated that the effectiveness of polyphenolic compounds was highly dependent on its stability, bioactivity and bioavailability. One technology that is more often used to increase the effectiveness of polyphenolic compounds is nano technology, since in the form of nano-particles the surface area increased and activity of the active compounds will increase as well. The main goal in designing nano-particles as a delivery system of the active compound is (1) to control the particle size, surface properties and release of pharmacologically active agents in order to achieve site-specific action of compounds at optimum levels;(2) increase the stability of the compound; and (3) having controlled release properties. Table bioactive compounds that can be isolated from seaweed can be seen in Table 2.

The advantage of using nano particles as the active compound delivery systems include the following: (1) particle size and surface characteristics of nano particles can be easily manipulated, (2) nano particles can control and sustain the release of active compounds during transport, thereby reducing side effects, (3) a controlled release of the active compound and degradation particles characteristics can be easily influenced by the choice of matrix constituents. The content of the active compounds can be incorporated into the system without a chemical reaction, it is an important factor for maintaining the activity of the compound (Hirano e/ *al.,* 1990).

Table 2. Bioactive compounds that can be isolated from seaweed (Hermanus et al., 2013)

No	General Category	Main Bioactive Type identified	Seaweed source
1	Karotenoid	β-karoten, fukosantin, zeasantin, lutein, violasantin, neosantin.	*Fucus serratus, Fucusvesiculosus,Fucus distichus, Fucus spiralis, Sargassum muticum,Saccharina latissima, Laminaria digitata, Dictyota dichotoma, Enteromorpha intestinalis, Ulva lactuca, Palmaria palmate, Porphyra purpurea, Chondrus crispus, Mastocarpus stellatus, Polysiphonia fucoides, Gracilaria vermiculophylla, Kappaphycus alvarezzi (Doty), Sargassum dentifolium, Laurencia papillosa, Jania corniculata.*
2	Fenol dan Polifenol	*Gallic, Protocatechuic, Gentisic, Hydroxybenzoic, Chlorogenic, Vanilic, Syringic, Caffeic, Salicylic, Caoumaric, Ferulic, Phlorotannins*	*Fucus serratus, Fucus vesiculosus, Fucus distichus, Fucus spiralis, Sargassum muticum, Saccharina latissima, Laminaria digitata, Dictyota dichotoma, Enteromorpha intestinalis, Ulva lactuca, Palmaria palmate, Porphyra purpurea, Chondrus crispus, Mastocarpus stellatus, Polysiphonia fucoides, Gracilaria vermiculophylla, Turbinaria conoides, Turbinaria ornate, Ecklonia cava, Ecklonia kurome, Ecklonia stolonifera, Eisenia bicyclis, Eisenia arborea, Ascophyllum nodosum, Sargassum kjellmanianum, Sargassum ringgoldianum, Sargassum siliquastrum, Ishige okamurae*
3	Pigmen fikobilin	Fikoeritrin, fikosianin	*Porphyra sp.*
4	Sulfat polisaka rida	Fukoidan, alginat, laminarin, galaktan, sulfat glikosaminoglikan , porpiran	*Laminaria japonica, Ecklonia cava, Ecklonia kurome, Undaria pinnatifida, Fucus vesiculosus, Fucus evanescens, Ascophyllum nodosum, Padina gymnospora, Dictyota menstrualis, Spatoglossum schroederi, Sargassum fusiforme, Sargassum thunbergii, Sargassum stenophyllum, Sargassum latifolium, Sargassum fulvellum, Gigartina skottsbergii, Chondrus ocellatus, Porphyra haitanesis, Gracilaria cornea, Grateloupia filicina, Grateloupia longifolia, Ulva pertusa, Ulva conglobata, Codium pugniformis, Codium cylindricum, Monostroma angicava, Monostroma latissimum, Monostroma nitidum.*
5	Vitamin	Provitamin A, Vitamin C, Vitamin E	*Fucus serratus, Fucus vesiculosus, Fucus distichus, Fucus spiralis, Sargassum muticum, Saccharina latissima, Laminaria digitata, Dictyota dichotoma, Enteromorpha intestinalis, Ulva lactuca, Palmaria palmate, Porphyra purpurea, Chondrus crispus, Mastocarpus stellatus, Polysiphonia fucoides, Gracilaria vermiculophylla.*

CONCLUSION

Several methods have been developed in the preparation of nanoparticles. Seaweed nanoparticles biosynthesis is a simple method that is environmentally friendly and does not require a lot of expense. Going forward, seaweed nanoparticles have promising potential for applications in nano- based biology, pharmacology and fiber-based industry.

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