Chapter 17
Algal Nanobiotechnology and Its Applications

Ahmed E. Alprol
National Institute of Oceanography and Fisheries, Egypt

ABSTRACT

Nanotechnology has been a catchphrase in recent years. Its expansion into a new field has been phenomenal. Because of their various shapes and sizes, nanoparticles differ from their conventional material. They have a larger surface area, which is necessary for many chemical methods. One of the possible solutions to the above-mentioned limitations is algae-mediated nanoparticle production. This chapter focuses on the use of algae to synthesis nanoparticles and the possible benefits of this technology over traditional methods. The creation of nanoparticles by cyanobacteria, microalgae, and macroalgae is taken into account. Metal nanoparticles derived from algae, such as gold, silver, and iron, have a wide range of applications in environmental pollution treatment, such as heavy metal removal, organic dye degradation, and antimicrobial agents, and examples of major biomedical applications of these algal-derived NPs are presented, among many others.

INTRODUCTION

In comparison to cereal-based crops, algae have been employed for a long time because of their high biomass production rate in a variety of severe habitats. Due to their numerous advantages over various agriculturally based crops, an alga is classified as a third generation biofuel. The idea of using algae to generate energy isn't new. Due to limited culture techniques, the cost of producing algal biofuels has been relatively expensive up until now. However, as time goes on, new methods are being developed for growing algae on a big scale all year, in a variety of climatic zones ranging from tropical to temperate (Batool et al., 2019). Nanotechnology is an area of science and technology that includes manipulating materials after they have been thoroughly consolidated and processed (Daniel, 2004). A variety of physical, chemical, and biological processes can produce nanoparticles. Particles are now generated in a vacuum or using other processing techniques.It uses a variety of processing methods, including atomic, molecular, and particle level processing as well as chemical modification. The main disadvantage is

DOI: 10.4018/978-1-6684-2438-4.ch017

the high expense of these approaches, as well as the low production required to use it as a material or for energy purposes. It is the consequence of a relationship between research and development and the private sector. In the near future, it is likely to have an impact on a variety of commercial industries, as well as a broad aspect of medical, defiance, and toiletries (Invernizzi, 2011). When compared to materials, the resulting (natural, engineered, or incidental) nanomaterials (e.g., nanoparticles (NPs)) have a dimension below 100 nm and unique physical–chemical–biological properties (e.g., large surface-to-volume ratio, surface functionalization, controlled targeting and release). These interesting features make them extremely appealing tools for use in a range of fields (e.g., cosmetology, pharmacy, biotechnology, chemistry, or agriculture).Algae are a large and diverse group of photosynthetic eukaryotic organisms that are both capable of photosynthesis (that is, they produce their own food using light, water, carbon dioxide, or other chemicals) and organization. It allows (that is, they produce their own food using light, water, carbon dioxide, or other chemicals). They are classed as microalgae (unicellular such as diatoms or multicellular) or macroalgae (seaweeds) based on morphological characteristics and can be found in both marine and freshwater habitats, as well as on damp rocks (Sharma et al., 2019). These water plants are non-flowering and basic. Despite the presence of chlorophyll, algae lack many structures (such as real stems, roots, leaves, and vascular tissue) that distinguish land plants (such as bryophytes and tracheophytes) (Borghans et al., 2008). Despite this, they play an important role in aquatic ecosystems (aside from the potential for toxic blooming, which can be controlled by algal-mediated NPs) and are an economically valuable biomass source for a variety of applications (including agricultural, aquacultural, pharmaceutical, cosmetical, biotechnological, energetical, and nanotechnological) (Wang et al., 2017). Green nanotechnology, particularly for algae, has recently been the subject of a lot of research because of its significant benefits over other technologies, such as high metal intake capability, low production costs, and environmental friendliness. It also reduces the need for culture maintenance because it is produced extracellularly. Algae have a diverse range of habitats (Zein & Gharib, 2014). Microalgae, which are microscopic, and macroalgae, which are macroscopic, are two types of algae. They could be eukaryotic or prokaryotic, and they can be found in a variety of environments ranging from freshwater to marine or saline water. Aside from nanoparticle manufacturing, they have the potential for use as natural colours, biofuels, and food enrichment, as well as in a number of other fields such as medicine, agriculture, and pharmaceuticals (Patel et al., 2018).Metal and non-metal NPs synthesized from plants (e.g., seaweeds) and microorganisms (e.g., bacteria) have gotten more attention than conventional physical and chemical synthesis routes, owing to their green assembly during biosynthesis, which uses clean energy processes that are naturally regulated, and therefore overcomes health and environmental toxicity .This chapter focuses on the important factors and methods involved in the algal-mediated synthesis of NPs such as gold, sulfated, palladium, silver, and many others, as well as their applicability in the real world. The fact that algae-mediated creation of magnetic nanoparticles can lead to increased growth and lipid formation in cyanobacteria and microalgae is established in another study. It also features an algal membrane bioreactor using nanoparticles, as well as (possible) biomedical uses. Finally, this chapter aims to aid in the development of safe and long-term nanotechnology generated from algal as aquatic environments.

TYPES OF NANOPARTICLE AND THEIR APPLICATIONS

There are two types of NPs that can be made using algae: organic and inorganic NPs. Poly-lysine (-PL), chitosan (CS), cationic quaternary polyelectrolytes, and quaternary ammonium compounds are examples