Micro-Algal Biotechnology

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Definition
Environment is everything including both the living and non-living things in the earth's ecosystem. Today the pollution of the environment is a serious concern facing humanity and other life forms in the world. The environment is daily polluted by natural and anthropogenic (man-mad) factors due to inattention and improper use of the existing science and technology. Several physicochemical methods are used for protection of the pollution in the environment but these techniques have its own advantage and disadvantage. In recent years, using biological methods specially, microalgae for environmental pollution protection is the best one, because it is suitable, produce less and or non toxic products, cost effective and eco-friendly methods to our environment. Microalgae are the important groups of living organisms used for biotechnological utilizations such as for environmental protection, Agricultural usage, biotul production, pharmaceutical production etc. without any environmental factor. This review focuses on the environmental applications of micro-algal biotechnology for treatment of wastewater nutrients, removal of heavy metals from the natural water, mitigation of CO₂, removal of dyes and dyestuffs from their effluents and their agricultural usage without any factor in the natural environment.

1. Introduction
Microalgae also called phytoplankton are the first life creature organisms which exist in the Earth’s ocean more than 3 billion years ago, when the Earth’s environment created. They are microscopic unicellular or simple multi-cellular structure; photosynthetic, prokaryotic or eukaryotic organisms that have chlorophyll and produce oxygen (O₂) by immobilizing carbon dioxide (CO₂) in the atmosphere through photosynthesis and also they can produce carbohydrates, proteins and lipids. Because of their simple morphological structure they can grow rapidly and live in harsh environment. Among prokaryotic microalgae Cyanobacteria (Cyanophyceae) and eukaryotic microalgae green algae (Chlorophyta) and diatoms (Bacillariophyta) are listed as an example. Biologists have categorized microalgae in terms of their pigmentation, life cycle and basic cellular structure in important classes of microalgae such as diatoms (Bacillariophyceae), the green algae (Chlorophyceae), the golden algae (Chrysophyceae) and the blue-green algae (Cyanophyceae). The minimal nutritional requirement of microalgal biomass is approximately estimated by the molecular formula CO₂₂H₁₄N₂₆O₁₉P₂₃ (Grobolabaz, 2004; Demirbas, 2010). About 100,000 different types of microalgal living in the oceans and in fresh water (lakes, ponds, and rivers). The main requirements for their growth and survival are sunlight, water, nutrients and arable land. Therefore; reproductive distribution of microalgae is mostly determined by environmental factors. Through their diverse modes of nutrition (phototrophy, heterotrophy, mixotrophy), microalgae can efficiently remove a wide range of chemicals from aquatic matrices. Recently, microalgae are the important groups of living organisms used for biotechnological utilizations such as for environmental protections (for wastewater treatment and used as biological tool for assessment of environmental toxicants), for production of foods, pharmaceutical applications, bioactive compound production, cosmetics production, agricultures and biofuels usage (Spolaore et al., 2006, Marques et al., 2011).

The use of microalgae in biotechnology is the best solution for environmental protection, however small size of single cells are difficult in the harvesting of microalgae after treating the wastewater in the application of biotechnological processes to those organisms. Therefore, cell immobilization techniques have been developed in order to solve those problems (Jimenez–Perez et al., 2004). The commonly used polymers for the microalgae immobilization are calcium alginate, carrageenan and chitosan. Among this immobilized microalgae beads are easy to harvest and reuse. De–Bashan and Bashan (2010) reviewed that an immobilized cell is defined as a cell that by natural or artificial means is prevented from moving autonomously from its neighbors to all parts of the aqueous phase of the system under study. Therefore, using immobilized microalgae are effective method for environmental protection. Environment is everything or the sum total of our natural world that can be including both the living and non-living things in the earth’s ecosystem. These environments are always polluted by different types of pollution such as water, air, soil, thermal, noise, radioactive, land, industrial, marine, personal, light, etc. pollsutions which can release physical and chemical wastes that causes harmful effects on the surrounding environments. Today on our planet most serious problems facing humanity and other life forms due to environmental pollution (the contamination of the physical and biological components of the earth/atmosphere system). Environmental pollution, the large volume of compact and non-degradable waste materials, heavy air pollution, continual destruction of the ozone layer, and severe climate change are all due to inattention and improper use of the existing science and technology. There are many causes for environmental contaminations. Among these causes environment ecosystem and natural water bodies are contaminated with wastewater nutrients (which leads to eutrophication, toxic chemicals from agricultural and pharmaceutical products and toxic gases from various industries. This wastewater are comes from textile, pharmaceutical, paper, beverage, horticultural, etc. industries. These contaminants can reach into our drinking water supplies but endanger aquatic ecosystems and other organisms. Therefore suitable treatment of the wastewater nutrients before discharging into water bodies is required. To remove these contaminants from wastewater the recent technologies used are expensive, produces highly sludge content and harsh to the nature. To avoid the negative impacts caused through the removal of contaminants, environmentally friendly and sustainable methods should be applied. Microalgae are the alternative biological treatment methods to remove nutrients (Mallo, 2002). But there is a limitation to develop wastewater treatment systems based on microalgae during harvesting process of their biomass at the final of treatment process. To solve this problem immobilization of cells are the best choice mechanism that used to increase the cells retention time within the bioreactors and higher metabolic activity (Tam et al., 1994).

The other causes for contamination of the natural waters are dyes and dyestuffs from wide range of textile, leather, plastic, paper, paint, food, pharmaceutical, cosmetics and other significant manufacturing industries. The purposes of dyes are to produce different color combinations to meet the demands of fashion, to produce brightness and other. These dyes have different structural and chemical properties i.e. acidic, basic, reactive, azo, diazo, disperse, and others. Annually more than 100,000 commercially available dyes and nearly 1 million tons of dyestuffs are produced worldwide (Garg and Tripathi, 2017). The textile industry is an important and the major industrial economic sector in Ethiopia, contributing total earnings of ETB 980.0 million (US$ 49 million) from manufactured exports in 2014 (Ethiopian Textile Industry Development Institute (ETIDI, 2016)). The different process stages of textile industry uses a large amount of water for dyeing, printing, and bleaching, which producing a large quantity of wastewater. Therefore; every year high amount of polluted effluents are discharged from textile processing which consumes large amounts of water. These effluents from textile industries are characterized by high salinity, temperature and chemical oxygen demand (COD) and strong color (Martavinos and Pašlakis, 2004). As a result removal of textile dyes from the effluent before its disposal in the water bodies is extremely important. Although several physical and chemical methods have been developed for removal of dye from textile effluent, these methods are not suitable due to the production of large amounts of toxic sludge, aromatic amines, and other secondary waste products. Because of their sustainability to the environment, cost effectiveness, eco friendly nature, and produces less toxic and/or non-toxic products, numerous biotechnological approaches using microalgae have been recommended to overcome the problem of physicochemical treatment methods using microorganisms for the treatment of textile dyes and industry effluent as microorganisms play vital roles in the mineralization of xenobiotic compounds (Kurade et al., 2012).

The emissions of CO₂ are the other causes for the environmental contamination and the worlds concern. The increment of concentrations of greenhouse gases in the world’s atmosphere is leading fear to a greater extent. Among the greenhouse gases CO₂ is the main one and it was released 28.8 gigatonnes into the atmosphere in 2007 alone (International Energy Agency, 2009) and the IEA
also predicted that this number would be reach to 34.5, 40 billion tons by the year 2020 and 2030 respectively, an average rate of growth is 1.5% per year. Agricultural synthetic fertilizers and heavy metals are the other causes of environmental pollutions.

The article of this review focuses on the environmental applications of microalgae for the treatment of wastewater nutrients, removal of dyes, and dield and detergents from their effluents, mitigation of CO₂, removal of heavy metals from the natural water, and their agricultural usage without any factor in the environment. Using micro-algal processes for the removal of contaminants is still not widely used and adequately studied in Ethiopia. In Ethiopia there is no known documented micro-algal distribution and resources for biotechnological applications until this time. The aim of this paper is to address the various biotechnological applications of microalgae in the environment and to offer attention for micro-algal biotechnology researches in Ethiopia.

2. Application Micro algal biotechnology for removing pollutants from polluted environments

2.1 Application of Micro algal biotechnology for Wastewater treatment

As we know water is the most basic and essential compound of all living processes in our water planet and it should be treated before usage. Wastewater is the water with poor quality that contains more amounts of pollutants and microbes. Wastewater contains different types of materials like soluble organic, inorganic, insoluble inorganic materials, macro solids, toxins, etc. and the soluble parts of wastewater by-processing like carbon, nitrogen and phosphate which are used for the microalgae cultivation. The discharge of wastewater containing various contaminants into the aquatic ecosystems or water bodies is a major concern for our environment and to public health. These contaminated wastewater compounds may be cause physical, chemical, biological, and environmental impacts in aquatic habitat, biodiversity and water quality (Aleem, 2003). Wastewater treatment is the significant measure to reduce the pollutant and other contaminants present in wastewater. RAWAT et al. (2010) reviewed that there are three treatment methods of wastewater these are: the primary treatment method which is the first step in wastewater treatment method that removes the solids, oil, and grease from wastewater. Secondary treatment or biological treatment method is the second step, which absorbs microorganisms to eradicate the chemicals present in wastewater. The tertiary treatment method is the final step; which eradicates the microbes from wastewater before discharging into the river. Although many attempts to stop the destruction and pollution of water resources, it requires an attention on the necessity of the use of new methods to prevent contamination of water resources (Delplanque, 2013). Microalgae wastewater treatment is an eco-effective method of nutrient removal, biomass production and effective way of nutritions regeneration in environmental biotechnology, mainly for bioremediation, bioassay and biomonitoring of wastewater and toxicants (Mulbury et al., 2008).

The high rate algae pond (HRAP) system has been shown to be an effective system to treat wastewater (Hoffmann, 1998; Phang et al., 2001). The system consists of shallow pond mixed by paddle-wheels to improve nutrient transfer and photosynthetic efficiency to optimize algal growth. The HRAP system is particularly suitable for tropical climate with the warm weather and abundance of sunlight throughout the year. HRAP used for efficient reduction of pollutants such as chemical oxygen demand (COD), biological oxygen demand (BOD), nutrients (nitrogen and phosphorus). Microalgae grown in HRAP were advantageous in treating various wastewaters such as rubber effluent, palm oil mill effluent (POME) and municipal wastewater (Garcia et al., 2000; Phang et al., 2001). Spirulina platensis grown in HRAP have been used to achieve to reduced 98.0%, 99.9% and 99.4% chemical oxygen demand, ammoniacal-nitrogen- and phosphate respectively from anaerobically digested starch factory (Phang et al., 2000). In certain studies combination of numerous microalgae has high efficiency in wastewater treatment. For example a group of five microalgae, Chlorella vulgaris, Scenedesmus quadricauda, Euglena gracilis, Ankistrodesmus convolutus and Chlorella ellipsoidea grown in HRAP was successfully used to treat landfill leachate (Mustafa et al., 2012). In other studies dual uses of Chlorella sorokiniana and Scenedesmus obliquus cultivated with in filtered raw sewage were used for biomass production and wastewater treatment without the requirement of any additional treatment. In this study S. obliquus showed greater potential for removing organic carbon (76.13 ± 1.59% COD removal), nutrients (98.54 ± 3.30% N-removal, 97.99 ± 3.59% P-removal) and comparable pathogens removal (99.93 ± 0.12% total coliforms removal, 100% faecal coliform removal) in comparison to C. sorokiniana (69.38 ± 1.81% COD removal), (98.93 ± 3.49% N-removal, 68.34 ± 1.12% P-removal), (98.78 ± 0.12% total coliforms removal, 100% faecal coliform removal) (Gupta et al., 2014). Mostafa et al. (2012) reported that the nine microalgae species of (green and blue green microalgae)Chlorella vulgaris, Spirulina platensis, Nostoc humicicum Nostoc muscorum, Anabena flos aquae, Anabaena oryzae, Phormidium fragile Woeiea saccata, and Oscillatoria sp., on domestic wastewater are effective in nutrient removal and also using the domestic wastewater as nutrient media for microalgae cultivation is appropriate and low-cost compared to the conventional cultivation methods. In the semicontinuous operating mode immobilized Chlorella vulgaris and Scenedesmus obliquus were effective in removing phosphorus and nitrogen from urban wastewater (Ruiz-Marin et al., 2010). Another study shows that, co-immobilization of microalgae and bacteria co-immobilization was more efficient in removing nutrients for instance nitrate, ammonium and phosphate from wastewater more willingly than immobilised microalgae lacking bacteria (De-Bashan et al., 2002). Zhang et al. (2008 & 2012) also reported that Immobilized Scenedesmus sp. and Chlorella sp. isolated from municipal wastewater, entrapped in calcium alginate as algal sheets was employed to remove inorganic nutrients (NH4 (4-) +N and PO4 (3-) P) and the removal efficiency for Scenedesmus sp. was 100% after 135 min and 15 min respectively and for Chlorella sp. was 98.81% and 100% respectively after 4 h in domestic secondary effluents, from artificial and real domestic wastewater effluent in parallel plate bio reactor after starvation. These two immobilized microalgae (Chlorella vulgaris and Scenedesmus rubescens) were also used to remove phosphate, ammonium and nitrate from wastewater to less than 10% of their initial concentration within 9 days in the twin-layer photobioreactor system (Shi et al., 2007). The investigation indicates that using this twin-layer system technology for algal cell immobilization has 100% cell immobilization than the other methods, because the method can successfully separate microalgae from the bulk of their growth medium. The twin-layer system is the new technology for cell immobilization technique that used for removal of nutrients from wastewater and an effective means to reduce nitrogen and phosphorus levels in wastewater. Chlorella vulgaris were also effective for bioremediation in removing NH (4)-N (44.4-45.1%), PO (4)-P (33.1-33.3%) and COD (38-36-2%) from textile wastewater (Lim et al., 2010). The microalgae Chlorella sp. has the removal efficiency in the percentage of 90.8, 80.1, 98.9, 87.6, and 90 % of the waste nutrients BOD, COD, NH4-N, NO3-N and PO4-P respectively (Hammouda et al., 2015).

2.2 Application of micro algal biotechnology for Removal of heavy metals

The major environmental concern of water bodies are contamination by heavy metals because these contaminants are very toxic, xenobiotic and or recalcitrant and exhibit a bioaccumulation tendency (Pacheco et al., 2015a). Metals such as sodium, magnesium, calcium, nitrogen, potassium, iron, copper, manganese, molybdenum, vanadium, manganese, cobalt, zinc and nickel are vital for biological functions that are directly or indirectly involved in all phases of microbial growth. Whereas, heavy metals like mercury, cadmium, arsenic, antimony, chromium, silver, gold and lead are not well-known to have essential biological functions in microbial growth. Among the 19 heavy metals lead, cadmium, and mercury are known to be extremely toxic. Heavy metals constitute a diverse group of elements with varied in their chemical properties and biological functions. Heavy metals can enter into aquatic systems as a result from Anthropogenic activities (mining, smelting operation and agriculture) as well as natural activities which locally increased the levels of heavy metals such as Cd, Co, Cr, Pb, As and Ni in soil up to dangerous levels. Although the presence of these heavy metal ions are used in industrial, pharmaceutical and agricultural processes; they are highly toxic and carcinogenic to human beings, alter biochemical cycling of living bodies, serious damage to the aquatic life and causes teratogenesis changes in plants, animals and humans (Shanab et al., 2012). They are also integrated into the food chain and accumulate along the different trophic levels producing harmful effects, especially to consumer organisms of the top of these chains. Heavy metals contamination is a serious issue of concern around the world due to the increase in the use and processing of heavy metals during various activities to meet the needs of the rapidly growing population. Soil, water and air are the major environmental compartments which are affected by heavy metals pollution. Using
immobilized microalgae in biotechnology is the solution to reduce the contamination of heavy metals. For instance, most of immobilized Chlorella sp. in alginic beads was useful in removing heavy metals like Cd²⁺, Ni²⁺ and Pb²⁺ ions in 25mL initial concentration of each metal 97.1%, 50.94%, 64.61% removal and 150.07, 48.87, 101.73mg/l biosorbent, respectively at PH 5 for 180 min from drinking water (Petricov and Simonic, 2016). And also immobilized Chlorella sp. in alginate beads was useful to remove 98% chromium (VI) in the concentration of 75mg/L at PH 3 for 9 days from synthetic waste water (Rao et al., 2013) and consistently (>98%) removal and (about 100%) recovery of lead and cadmium at the concentration of 50mg/L at PH 6 for 4 days (Hamed et al., 2010). Additionally immobilized Chlorella sp. in alginate beads was useful to remove 59.67% Cadmium in the concentration of 20 ppm for 60 min in aqueous solution (Vaidhe et al., 2018). Akhtar et al. (2003) also investigated that free and immobilized Chlorella sorokiniana removed cadmium from 10 mg/l-1 solution at the efficiency of 92.7% and 97.9% respectively. The immobilized Anabaena sp. system has been investigated as a potential biosorbent for the removal of 80 % cadmium from aqueous solutions and the full adsorption time taking place 50 min (Clares et al., 2015). Microalgae are used in bioassay of organisms to examine the toxicity of harmful pollutants for instance heavy metals, pesticides and pharmaceuticals. The three fresh water microalgae Phaeodactylum tricornutum, Pyrocystis noctiluca and Scenedesmus quadricauda could be used for removal and tolerant of mercury (Hg⁰), lead (Pb⁰) and cadmium (Cd²⁺) in aqueous solutions as a single metal species at concentration of 5-10 mg/L under controlled laboratory conditions and among the three species, P. tricornutum is said to have a maximum performance of the highest percentage of metal bioremoval occurred in the first 30 min of contact recording 97% (Hg⁰), 86% (Cd²⁺) and 70% (Pb⁰) respectively (Shanab et al., 2012). The cells of Oscillatoria limosa was used for bioassorbtion of the three metals (10.8 mg/g biosorbent in 40 mg/L concentration Cd, 17.2 mg/g biosorbent in 80 mg/L concentration Hg in 60 mg/L concentration Pb) and their order of removal was found to be 82, 78 and 72% at 120 min respectively (Sivakami et al., 2015). Fekry et al. (2018) also reported the microalgae strains namely Anabaena flos aquae, Nostoc elongatus, Nostoc linckia, Anabaena variabilis and Chlorella vulgaris, were effectively remove the heavy metals Chromium, lead, iron, copper, Molybdenum and arsenic from the textile wastewater effluent after 4 weeks incubation periods under continuous illumination. Hammouda et al. (2015) also reported Chlorella sp. have the ability to remove heavy metals in the percentage of nickel (95.5 %), Mn (73.2 %), Fe (92.2 %), Cu (54.5 %), Zn (51.4 %), Cr (56.3 %), Mo (99.7 %), Al (98.8 %), Si (48.5 %), V (100 %), Ti (100 %), Sr (41.9 %).

2.3 Application of micro algal biotechnology for CO2 sequestration

In the last 50 years the emissions of CO2 have been raised radically and still continue at the rate of 3% annual increase. A long time existence of the earth’s atmospheric temperature or global warming is caused by the emission of greenhouse gases. In the earth’s atmosphere the primary greenhouse gases (GHG) are Carbon dioxide (CO2), Methane (CH4), Nitrous oxide (N2O), Hydro fluorocarbons (HFCs) and per fluorocarbons (PFCS), these are human origin gases that contribute up to 85% of the total to boost in global warming. Although the duration of these gases varies in the atmosphere, it’s very high at all times i.e. 80% lasts for 200 years and the other 20% can take up to 30,000 years to reach its minimum. Among these gases CO2 is in charge for over 60% of the level of global warming as the result of fuel use, deforestation, production of cement and other causes (Huang and Tan, 2014). Fossil fuels, together with oil, coal and natural gas, are providing about 85 % of energy globally. The requirement of energy is increasing continuously because of increase in industrialization and population. Continuous uses of fossil fuels and their combustion lead to emission of greenhouse gases like carbon dioxide, nitrous oxide, methane and volatile organic compounds (Gavilés et al., 2006; Verma et al., 2010). Combustion of fossil fuels emits harmful gases into the atmosphere and 73% of the CO₂ in the atmosphere comes from burning of these fossil fuels (Verma et al., 2010). By means of rapidly rising world energy demand and high fossil fuel prices, a forced need is being focused on the photosynthetic organisms which can store lipoic in the form of triacylglycerides (TAGs), produces renewable energy that can be the best alternative to limited oil resources, it is environment-friendly nature and also it shares a total of low GHG emissions compared with fossil fuels. Although various CO₂ capture technologies have been proposed, photosynthetic microalgae can be the greatest alternative for the future due to its higher phase, use of unproductive lands, exhausting non-renewable resources and its ability to grow on wastewater by using broad variety of nutrient. Microalgae are most suitable in mitigation of climate change because it reduces the emission of fuel gases and have fast growing capability due to the consumption of CO₂ and having more oil content than any other source. Microalgae are also able to produce biomass (which results the releases of oxygen (O₂) into the atmosphere) from solar energy, CO₂ and nutrients in the water bodies. Currently these biomass are the alternative micro algal based sources of energy for production of various types of Biofuels for example: Biodiesel (Chisti, 2007; Craggs et al., 2011; Kumar et al., 2013), Biodiesel production from Wolfia saccata, Anabaena flos aquae, Oscillatoria sp., Anabaena oryzae, Spirulina platensis, Chlorella vulgaris, Phormidium fragile, Nostoc muscorum and Nostoc muscorum (3.9, 4.0, 4.3, 4.5, 7.8, 8.8, 10.1, 10.2 and 12.52 % respectively) in the synthetic media and Oscillatoria sp., Wolfia saccata, Anabaena oryzae, Spirulina platensis, Anabaena flos aquae, Nostoc muscorum, Phormidium fragile, Chlorella vulgaris and Nostoc muscorum (3.8, 4.0, 4.7, 5.0, 5.0, 7.4, 8.4, 8.5, and 11.8% respectively) in the domestic wastewater (Mostafa et al., 2012), Bioethanol production from Scenedesmus dimorphus under carbon dioxide enriched air (Cheng et al., 2017) and from Arthrospira (Spirulina) platensis by enriched air (Cheng et al., 2017). Enriched biomass (Markou et al., 2013), Biogas production from Chlorella vulgaris and Chaetoceros sp. by microalgae fermentation respectively (Parazzoli et al., 2013, Negara et al., 2017). Bio-hydrogen production from the wild-type of Chlorella sorokiniana a green microalgae produce hydrogen in photo biosensor coupled to a small Proton Exchange Membrane Fuel Cell (PEMFC) (Chader et al., 2011). Recently, cultivation of microalgae has established new consideration on account of their utility as an achievable CO₂ sequestration technology (Oro and Cuello, 2015; Hsieh et al., 2017; Jacob Lopes et al., 2008; Verma et al., 2010). A number of the green microalgae genera such as Dunaliella, Chlorella, Euglena, Batyribococcus, Scenedesmus and Chlorella are the effective carbon sequesters (Bhola et al., 2014). Also several studies have been carried out from time to time for the determination of micro algal ability to hold up the high CO₂ concentrations. Microalgae are minute that has to some extent greater photosynthetic efficiency other than plants and they are sunlight driven biochemical factories and very effective CO₂ fixers (Verma et al., 2010). Some species of microalgae able to biograde the chemical groups of polymeric acid hydrocarbons (PAHs) other constituents of crude oil and refined petroleum products. For instance Chloroalfa vulgaris, Scenedesmus quadricauda, microalgae Chlorosarcina dubia and Raphidocloca cornucroemum on fluorantheme (1.0 mg l⁻¹), pyrene (1.0 mg l⁻¹), and a mixture of fluorantheme and pyrene (each at a concentration of 0.5 mg l⁻¹) within 7 days of treatment are used to degrade PAHs (Lei et al., 2007). Hannan et al. (2010) reported that about 40% of the primary CO₂ gas as the main cause of global warming, attenuation of greenhouse gas effect, biofuel and valuable secondary metabolites production and carbon balance worldwide.

2.4 Agricultural uses of micro algal biotechnology in the environment

Agriculture was accomplished in the world for a long period of time by human beings without the use of any synthetic fertilizers. But, after many years usage the soil fertility was gradually diminished and agricultural productivity was decline worldwide. Therefore, because of the increment of world’s population growth; imbalance demand and supply was happened, in order to solve this problem for the last 50 years farmers become mostly depend on man-made chemical fertilizers and pesticides to improve crop yield and to increase productivity. The present concern is those chemically active fertilizers or pesticides, because using synthetic chemical fertilizers and pesticides causes to various forms of environmental degradation i.e. pollution of air and water; soil depletion; diminishing biodiversity; polluting soil, water and air; and damaging both the environment and human health. Hence, to reduce environmental pollution, to maintain soil fertility, to increase crop productivity and quality, to reduces the amount of the use of chemical fertilizers and pesticides use of alternative source of nitrogen fertilizer is important. The use of microbial products, functional bio-fertilizers and bio-controllers is the crucial alternative and effective ways of methods to control the environmental pollution, to recover soil fertility (soil reclamation) to improve crop production and nutritional quality, biocontroling of agricultural pests, formation of microbialost structure, agricultural wastewater treatment, recycling of treated water and to substituting costly inorganic nitrogen fertilizer in agriculture. Among these...
biofertilizers microalgae species are an optional and economically attractive to be used as organic and cheap source of N2, which does not cause soil and water pollution instead of using the expensive and environmental polluted industrial chemical fertilizers. Today Nitrogen-fixing forms of microalgae act as biological or natural fertilizers for rice and other crops. For instance, rice cultivation inoculated with marine chlorophyta, Chlorella vulgaris and Spirulina platensis can be used as biofertilizer to enhance rice yield up to 7-20.9% respectively (Dineshkumar et al., 2018). Other study investigates that the use of microalgae polysaccharides as biofertilizers of plants growth on tomato (Solanum lycopersicum) and pepper (Capsicum annum) plants at different growth stages by spraying the total polysaccharides extract (TPE) from Spirulina platensis was increased the plants sizes, roots and number of nodes per plants (Elarroussi et al., 2016). Cellular extracts and dry biomasses of the green algae Acutodesmus dimorphus culture, applied as a biostimulant, foliar spray, and biofertilizer, respectively, were able to activate faster germination, enhance plant growth and fruit production in tomato plants (Garica-Gonzalez and Sommerfeld, 2018). In another research findings; the use of cyanobacterial as a biofertilizer should be suggested as an alternative source of inorganic N-fertilizer to increase yield and nutritional quality of kale crop for medium and small-sized farms in the study area (Eshetu et al., 2018). Cyanobacteria also known as blue-green algae are rich in the presence of phycocyanin and phycoerythrin which frequently cover the chlorophyll pigment are the primeval group of prokaryotic microorganisms around for nearly 3.5 billion years and exhibiting the general characteristics of gram-negative bacteria and they are considered as one of the sole and important primary producers in the biosphere, as these prokaryotes possess chlorophyll a and conduct oxygenic photosynthesis contributing a major portion of the carbon fixation on earth, turning greenhouse gases into carbohydrates and lipids (Beth et al., 2015). Cyanobacteria have an important role as a natural biofertilizer to maintain and increase soil fertility, as a result increasing crop production. They are the major co., cyanobacteria as a biofertilizer have the advantages of lower cost and reduced production of greenhouse gases such as, nitrous oxide and carbon dioxide by 30% which results in less pollution of the environment (Eshetu et al., 2018). Cyanobacteria also used as biocontrol agents. In the currently agricultural practices, the conventional pest control methods have not been efficient and chemical pesticide agents inhibit the growth and development of crop plants (Manjunath et al., 2010). To solve this problem cyanobacteria play a major role as opposing agents against several pathogenic microbes, insects and weeds (Prasanna et al., 2013a). For instance, Natarajan et al (2012) has identified two novel fungoidal compounds as benzoic acid derivative and majuscula amide C from Calothrix elenkinii and Anaibaena lava respectively. In other finding compounds Chitosanase homologues and micro cystin which have the fungoidal activity were identified from Anaibaena lava, A. jyengari and A. fentillisima (Gupta et al., 2012). Microalgae also have the ability to stimulate growth activity as plant growth promoters. For example, the microalgae genera Chlorella, Scenedesmus and Chlamydomonas were tested and show phyto-stimulation and phyto-toxicity activity in cucumber seeds (Pathi et al., 2015). The recent findings established that cyanobacteria improves the growth of rice, wheat, and chil plants and soybean respectively proven in pot experiments (Narayanan and Shokkary et al., 2012). Results of these study showed that shoot length, root length, leaf area, plant weight and the number of leaves increased significantly with the addition of combined nitrogen compared to plants not fertilized with nitrogen. Other study shows that long-term usage of synthetic chemicals leads contamination of the soil. For instance, long-term use of DDT (1,1,1-trichloro-2,2-bis(p-chlorophenyl) ethane) to control arthropod disease-vectors and agricultural pests causes contamination on soil biological properties which leads to loss of soil fertility (Megharaj et al., 2006). This study suggests that organisms especially microalgae are used as bioindicators. As we know chemical areas are only used to determine the contents of the pollutants; but bioindicators can really assess the biological effects on living organisms. Because of their sensitivity to the presence of toxic chemicals, microalgae have the ability to estimate the ecotoxicity, genotoxicity and environmental risk of pollutants both in soil and sediments. Hence, microalgae are often included in the bioassays of environmental pollutants. The common microalgae used for bioassays of toxicants include Pseudokircheniella subcapitata, Dunareaa tertiolecta, Isochrysis galbana, Chlorella sp. (Vannini et al., 2011). Discharge of extra nutrients from fertilizers and industrial wastewater to the aquatic environment can activate overgrowth of microalgae that causes eutrophication (Smith, 2003). Microalgae namely, Chlorella vulgaris, Scenedesmus quadricauda and Ankistrodesmus convolutus were found to be useful for the assessment of nitrogen and phosphorus enrichment in freshwater ecosystems (Chu et al., 2009). Therefore; the use of microalgae as bio-fertilizer was used to reduce the polluted synthetic fertilizers use, used for estimation of environmental pollutants due to their bioindicator activity, maintaining soil fertility and or production of oxygen, and to decide the potentiality of bio-fertilizer application in order to have maximum yield as well as for ensuring eco-friendly environment by avoiding chemical pollution. 2.5 Application of Micro algal biotechnology in Dyes and dyestuffs removal

A dye is a colorant substance that chemically bond to the substrate to which it is being applied in aqueous solution and dyestuff is the derived term of dye that is any soluble pigment. Due to their various structure dyes are difficult to classify; however, they are generally classified into two groups and classes depending on their source, general dye structure and the fiber type as follows: 1) Natural dyes: natural dyes are dyes that are produced from the natural plants for instance; Madder and from animals for example Tyrian purple (sea snails). 2) Synthetic dyes: dyes that are artificially produced from living organisms. Synthetic dyes are also divided into azo dyes and non azo dyes. Azo dyes contains basic instance, acid, vat, sulfur, disperse dyes and reactive (based on chemical reactions of azo compounds forming chloro-triazine dye, vinyl-sulfone dye, mixed dye etc. and based on dye application for example; cold Brand dye, medium brand dye, high brand dye) (Ajam et al., 2014). Generally dyes, pigments and dyestuffs are important in textile, paper, paint, plastic, food, cosmetics, pharmaceutical and other industries for coloration of paper, cotton, leather, wool, silk, nylon; used as pH indicator, painting multiple products, light-reflecting signs, heat and ultraviolet light (UV) resistant etc. Despite of, their applications for different industry processes, dye products are physically horrible nature and toxicity in the environment. Continuously increasing vast production rate of dyes due to increasing textile, textile waste and population growth have led to the obligation of effective treatment of their wastes. Therefore, a wide range of technologies has been developed for the removal of these challenging and dangerous dye wastes to reduce environmental impacts (Ajam et al., 2014). Among these technologies physical techniques such as; activated carbon, adsorption, reverse osmosis, ultra filtration can be used for dye removal however, these process causing secondary pollution. Chemical techniques such as; chlorination, ozonation, adsorption on organic or inorganic matrices, precipitation, chemical oxidation processes, advanced oxidation processes, Fenton and photo-Fenton catalytic reactions, H2O2/UV processes and photo degradation through photo catalysis) are also can be used for dye removal, however; toxic unstable metabolites as a result of most of these processes imparts adverse effects on animal and human health. Biological techniques involving microbiological or enzymatic decomposition and biodegradation under aerobic and anaerobic condition have also been used for dye removal from wastewaters however; the process results incomplete mineralization of toxic and carcinogenic by-products. Hence, the above-mentioned techniques have their own draw-backs. Due to their considerable hazard, several authors have attempted to find new forms of treatment to reduce the serious environmental risks caused by various dye effluents. To overcome the above treatment techniques problem numerous biotechnological approaches by using microalgae have been recommended because these methods are sustainable to our environment, cost effective, eco friendly nature, and produces less toxic compounds. El-Sheikh et al. (2009) investigated that some algae’s from different categories such as Chlorella vulgaris, Lyngbya lagerteni, Nostoc linxia, Oscillatoria rubescens, Elakathothir vinidis and Volvox aureus have the ability to decolorize and remove methyl red, orange II, G Red (FN-3G), basic cationic, and basic lutein dyes from ~4% to 95% according to the algal microalgae have been recommended because these methods are sustainable to our environment, cost effective, eco friendly nature, and produces less toxic compounds. El-Sheikh et al. (2009) investigated that some algae’s from different categories such as Chlorella vulgaris, Lyngbya lagerteni, Nostoc linxia, Oscillatoria rubescens, Elakathothir vinidis and Volvox aureus have the ability to decolorize and remove methyl red, orange II, G Red (FN-3G), basic cationic, and basic lutein dyes from ~4% to 95% according to the algal species, its growth state and the dye molecular structure. Over 90% Indublinit (TBT) could effectively remove at different contamination level for six cyanobacteria by bioremediation (Luan et al., 2006) and effective microbial deterioration and biooxidation 48.6 % color at initial concentration of 7.25mg/L from textile dyes and textile factory wastewater (Chu et al., 2009). In another study the five microalgae strains that is Nostoc ellipsosporum, Chlorella vulgaris, Anaibaena variabilis, Nostoc linckia and Anaibaena were evaluated for their efficiency to remove the red color of the textile wastewater effluent for 4 weeks incubation under continuous illumination. In this study the percentages of these microalgae color removal were 100. 96.16, 88.71, 79.03 and 50.81 % respectively at 600 nm absorbance (Fakry et al., 2018). Other study shows that in the high rate algae pond (HRAP) system usingChlorella vulgaris was a good system for final polishing of textile wastewater before discharge, mainly for removal of colour from 41.8% to 50.0% in a range of 0.17 to 2.26 mg chlorophyll a/l (Lim et al., 2010).
3. Conclusion

As conclusion using microalgae technologies system have become many applications in our life and world’s environment especially for developing country like Ethiopia. Microalgae have unicellular or simple multi-cellular cell structures and are able to survive and reproduce in almost all environments, that can tolerating a variety of environmental conditions and contaminants. Because microalgae’s require only water, light, nutrient and CO2 for their growth and they are fast-growing, sustainable to our environment, cost effective, and produces less toxic compounds using microalgae for environment application has multipurpose role. In the future using these microalgae technologies is the solutions for our environmental problems and changes.

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