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GREEN MINING EXTRACTS ZINC, NICKEL AND COBALT FROM PLANTS/ REVIEW ARTICLE

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Abstract:
The demand for metals is constantly increasing as a result of economic and urban growth and population growth, as they are a major component of modern technologies and industries. However, the aspects of mining activity currently used have negative impacts on the environment, human health and existence. Will scientists in the future be able to discover innovative technology to use synthetic biology and engineer plants and stimulate them so that they are able to produce minerals sustainably? Soil contains many minerals that plants use as nutrients throughout their life cycle for their growth among the minerals necessary for this growth cycle are: phosphorus, potassium, calcium, sulfur, magnesium, copper, zinc, iron, manganese, molybdenum, boron, nickel, cadmium, and cobalt.

Keywords: Green Mining , Plant Technology, Extracts Metals

A review Article Problem: In terrestrial areas, mining leads to the destruction and disturbance of ecosystems and surrounding environments. In agricultural areas, this may disturb or destroy grazing and agricultural productivity. In urban environments, mining may lead to noise pollution, dirt pollution, and visual pollution.

A review Article Objective: There are types of plants suitable for extracting minerals, as an alternative source to traditional mining methods that have a negative impact on the environment. Plants that concentrate metals in their tissues may be a promising source in this process.

The method of the article: It is based on a select few species of plants that can absorb minerals from the soil, such as zinc, selenium, nickel and cobalt.

1-INTRODUCTION

The plant's roots extending deep into the ground absorb water, nutrients, and minerals from the soil, which are then transported to all parts of the plant, including the leaves, via the stem. This absorption capacity varies from one type of plant to another. Some have a great ability to absorb and accumulate metals in their biological mass, with certain metals accumulating in living tissue to levels greater than normal for other plants growing in similar soil [1]. This property opens a scientific door to exploring suitable plant species for extracting minerals, as an alternative source to traditional mining methods that have a negative impact on the environment. Plants that concentrate nickel in their tissues may be a promising source in this process[2].

1-1 Plants that store nickel

There are many types of plants that love nickel, and they grow in soil rich in this metal, where they absorb it greedily and then store it. Note that soil rich in nickel in high concentrations is not suitable for the growth of most plants, as nickel inhibits plant growth and contributes to disturbances in the biological and chemical processes that occur within the plant, such as metabolism and photosynthesis, and causes poisoning and death of the plant, these types of plants have very high levels of resistance to nickel at high concentrations. There are a number of scientific studies that indicate that nickel released into the atmosphere by volcanoes is responsible for the elimination of Australian plant life, before the death of animals and marine species. This extinction is called the Permian-Triassic extinction or the Great Dying[3].

Hundreds of species of nickel-loving plants have been recorded around the world, and new discoveries continue at a rapid pace to discover new species using X-ray micro-imaging technology. One of the types of nickel-loving trees is the *Pesnandra comminata* tree, which accumulates nickel at a rate of up to 25% in its milk, and is distinguished by its blue and green color due to nickel compounds. The discovery of this tree dates back more than forty years in the rainforests of

New Caledonia. Nickel has many uses in many industries, including the manufacture of stainless steel, and is an essential element in the manufacture of electric car batteries. Scientists have studied these plants, and many scientific hypotheses have been put forward to explain their development, according [4] including: They use nickel in defense and to protect themselves from harmful insects that chew the leaves, as the accumulation of nickel is toxic to most herbaceous insects, another hypothesis is that excessive accumulation of nickel has antifungal effects and reduces the growth of competing species of other plants. However, there is no scientific consensus to explain this yet, excessive accumulation of nickel may have evolved for different reasons in different lineages in the plant kingdom. Unfortunately, plants with excessive accumulation of nickel are threatened with extinction, due to their scarcity in the world, and are severely affected by environmentally destructive elements and human activities such as: mining, forest development, fires, and urban expansion[5].

1-2 Plants that extract gold

Researchers at the Technology and Engineering Laboratory at Massey University in New Zealand have developed a process of stimulating a plant known as Indian mustard to be gold-loving, and using it to obtain gold. They planted it in water containing nutrients in addition to gold chloride. Enzymes were used to break down plant cells to extract gold. They were actually able to obtain the equivalent of one gram of gold from ten kilograms of dried plants[6]. Although the quantity is very small and not commercially useful at the present time, such experiments will help in developing the process in the future to be more efficient and economically feasible, which may have positive repercussions on the mining level, especially in the field of precious metals[7]. In addition, the gold particles extracted from the Indian mustard plant are located at the nano-level and are called gold nanoparticles (AuNPs). Being nanoparticles makes them have exceptional properties that do not exist if the gold nuggets were large in size. Gold is an inert and chemically inactive element, but gold nanoparticles are very active in chemical reactions and have a promising future in many applications. In medicine, for example, gold nanoparticles are promising in treating cancer. Obtaining gold nanoparticles at the present time requires many expensive and environmentally polluting chemical reactions, and therefore, planting plants is the best environmentally friendly way to obtain this precious material. Studying and understanding these plants will help scientists treat them, engineer them, stimulate them to absorb minerals, and benefit from them for many uses, including: helping them grow in places other than their habitats, such as piles of dirt waste coming from mines, cleaning the soil from pollution and toxic elements, in addition to harvesting minerals from Other plants and their use in industrial applications, especially rare and precious metals. Later, its use may expand beyond that. Ultimately, we will have mineral crops such as nickel and gold, and we will then know that plants are not limited to producing agricultural crops only, but they also produce mineral crops [8].

1-3 Microbiological methods for mineral extraction and biomining According [9,10] Microorganisms can extract metals from their ores in two ways:

1-The direct method, in which organisms oxidize metal sulfides to obtain electrons, so cells need to be in direct contact with the surfaces of materials. When organisms are added to raw materials, they adhere to them in minutes, and the period may extend to hours until adhesion occurs, and the adhesion process is selective. The adhesion process begins with chemotaxis, which was observed when using copper, iron, and nickel ores, when using the bacteria Acidithiobacillus thiooxidans (formerly Thiobacillus), Leptospirillum ferrooxidans, and the genes were identified concerning chemotaxis in organisms used for mining. The cells form extrinsic adhesion compounds presence of exogenous polysaccharides plays an important role in the adhesion of cells to ores such as iron and copper removing these layers of cells leads to reducing the extraction efficiency , direct contact between cells and surfaces is necessary to move the minerals, and the interaction between cells and metal surfaces occurs on two levels:

A-Physical sorption results from stable electrical forces because the low pH that prevails in extraction environments causes the outer shell of the microbes to be positively charged, leading to stable electrical interactions with the salts.

B-Chemical sorption, in which chemical bonds are formed between cells and salts, such as disulfide bridges. In addition to the formation of metabolic substances by the cells during the adhesion process, including low molecular weight metabolic substances such as substances produced by sulfur oxidizers such as organic acids, including acids of the tricarboxylic acid cycle (TCA cycle) and other organic acids and Ethanolamine, in addition to the production of high molecular weight substances such as Lipids and phospholipids, so cells form a layer of Bacterial glycocalyx on solids.

2-The indirect method is through the ferric ion, which is produced by microbes' oxidation of the ferrous ions present in salts, and the cells do not need to be in contact with the metal.

Both methods can work in special cases, the direct method works when using organisms with materials that require contact, and the indirect method occurs in bioreactors consisting of rooms insulated with a dialysis membrane to avoid contact uses of microorganisms in extracting precious metals from ores that contain small percentages of them, in addition to the use of these organisms in cleaning polluted soil and water adjacent to mines, and the possibility of using many types of bacteria, fungi, algae, and some plants in future mining operations, where a type of oxidative bacteria that can gain energy from oxidizing elemental sulfur[11].

This technology has found great acceptance and has shown success in copper mining operations. This is because these processes suffer from the problem of the presence of some sulfur stuck in the copper ores, which is difficult to get rid of by traditional methods. From here, the idea of using oxidizing bacteria in this field emerged, which have the ability to rid copper of the sulfur stuck in it by breaking the bonds that connect them through the discovery of a type of bacteria that has the ability to secrete cyanide compounds that dissolve gold, these bacteria then devour the melted gold from its ores, after which these bacteria are collected and the gold is extracted from them. More of these bacteria can be released into gold reservoirs and the process repeated many times, each time extracting part of the gold from its ores. This technology is still in its early stages, and scientists are currently working on discovering new types of bacteria that have the ability to devour other types of metals from their ores, thus beginning a new era in the field of clean and environmentally friendly mining[12].

1-4 Biomining methods

Microorganisms are used to extract metals on a commercial scale from their ores or concentrates, and biomining processes are ancient human activities, but they were carried out without knowledge of the organisms involved in the process until the bacillus bacteria were isolated in 1950. On the other hand, traditional mining operations were and still are used as part of the most important steps, the most important of which is preparing the ores, usually by extracting them from the ground and crushing the materials to increase the surface area for the purpose of extracting the minerals using heat and chemicals[12]. Traditional mining operations are destructive to the environment, so biomining has been developed in various ways, such as biowashing and others, for the purpose of avoiding the use of harmful chemicals. Organisms were used to extract precious metals and remove sulfur from coal and oil, as well as in the final treatments of oil refining to absorb metals from them, it is better to isolate organisms from their environment and then use them in bioleaching bioreactors., this method is currently used to extract gold, copper, cadmium, and uranium[13]. .

The oxidation of ferrous ions is the most important in extracting and filtering metals from their ores, which are in the form of sulphides in most cases. Biology is used to perform certain functions during the mining process such as converting sulfides or oxides of insoluble minerals into sulfates dissolved in water, as in converting copper ore (Cus) Covellite and (Cu_2S) Chalcocite into dissolved copper sulphate $CuSO_4$[14].

Biology is used as a preliminary treatment to open up the salt structures in the ores to allow the chemicals to penetrate the ore structures and dissolve the required metals, as in removing iron, arsenic, and sulfur from gold ores arsenopyrite. The gold remains in the remaining salts, which makes it easy to extract it by traditional methods, which is the use of cyanide, it is known that not all salts or ores can be extracted using biological systems, and for the purpose of using biological systems, the ores must contain salts of iron or reduced sulfur. Therefore, ores that lack iron and sulfur can be extracted biologically if they are present with sulfuric ores. In addition, lactosulfide salts or raw materials can be extracted using organisms that produce organic acids such as oxalic, citric, and others that are produced by certain types of fungi[15].

There are four generations of green mining as a source of renewable energy, as it is obtained from biomass such as wood, agricultural crops, plant waste, animal waste, etc., and the use of these materials is in fact an exploitation of the huge solar collectors present on Earth to produce energy. These solar collectors are plants that convert the energy of sunlight and some chemical elements, through the process of photosynthesis, are transformed into carbohydrate molecules that form the basis of biomass in its various forms. Four generations of plant mining can be identified according [16,17,18]:

1 – First generation: Plant seeds and grains have been used to produce biofuels, including corn, wheat, soybeans, sugarcane, rape, barley, and others. The use of agricultural crops to produce fuel has been met with global protests and widespread objections, given that its production is at the expense of the global food basket, and causes the conversion of much of the agricultural land allocated for food production into biofuel crops at the expense of the sustenance of the poor in the world. This caused a significant rise in the prices of grains and vegetable oils.

2 - The second generation: It relies on plant waste, such as wheat stalks, corn, sawdust, hay, etc., from which cellulosic fuels, ethanol, biomethanol and biohydrogen are obtained. Despite the importance of using agricultural waste to produce fuel, it is criticized for depriving livestock of fodder, and agricultural soil of plant waste, which is an organic fertilizer that fertilizes it.

3 – The third generation: Algae is used because it contains a good percentage of oils, reaching 60 percent of its weight. Global interest in algae has increased because it does not compete with vegetable oils and agricultural crops intended for human consumption. Algae also does not add more carbon dioxide to the air, as what it consumes during its cultivation and growth is approximately equivalent to what it emits when the biofuel produced from it is burned. In addition, growing algae will not be at the expense of agricultural land, nor will it affect fresh water sources, as it can be grown using seawater or treated wastewater.

4 – Fourth generation: This generation is the latest global trend to produce it in an environmentally friendly manner, and it depends on making a change in the genome of a microorganism, a bacterium called "Mycoplasma Laboratorium," so that it becomes capable of producing fuel from carbon dioxide gas.

2- CONCLUSIONS AND RECOMMENDATIONS

Work is underway on an environmentally friendly alternative to extracting minerals from plants, to replace heavy equipment, in a development that could benefit one of the most polluting industries. This alternative, known as "phytomining" or "plant mining," relies on a select few species of plants that can absorb minerals from the soil, such as zinc, selenium, nickel and cobalt. The mining process currently used has negative impacts on human health and the environment, as it threatens biodiversity. Also, companies working in the field of mining use smelting furnaces, which consume a lot of energy. But plants carry out this natural process, that is, absorbing metal from the soil and collecting it in high proportions, relying on solar energy and the chemical reactions that occur within them. Therefore, researchers are working to study these types of plants and why they have evolved to absorb specific types of minerals voraciously. The way these plants work will help in engineering specific plants to be able to target precious metals such as silver and gold, especially since the science of synthetic biology is witnessing great progress, and through it it is possible to build biological systems that do not exist in nature. It is also possible in the distant future to have green and environmentally friendly factories that mimic the way plants work instead of metal smelting furnaces.

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