

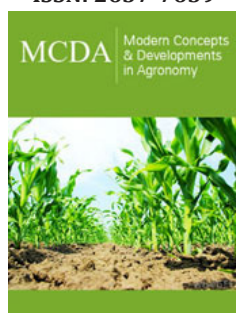
Food and Energy from Wastewater Sludge, Really?

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Abstract

There are areas of opportunities for food production and energy generation that demand creative technologies and that face the challenges of the future. Therefore, there are searches for strategies to obtain better resources, including wastes, such as wastewater sludge. The sludges contain various elements and chemical compounds that can nourish the plants and enrich the soil and its biota, so that they produce food with adequate quality, however, wastewater sludge must be treated before. As a possible source of energy, sludge can produce biogas under specific conditions. It is possible to take advantage of waste such as sludge, which has a window open for the reuse and use of sludge, towards research, to new possibilities of exploration of energy and materials. Due to its qualities, sludge has a great potential to regenerate eroded or degraded soils, as well as being useful to increase the production of some crops in an economical and sustainable way.

Keywords: Use of sewage sludge; Sustainable agriculture; Wastewater sludge alternative use

Abbreviations: WWS: Wastewater Sludge; WWTP: Wastewater Treatment Plants

Introduction

Food production and energy generation are activities that year after year demand new technologies and face challenges of diverse nature. Therefore, strategies are sought to make better use of resources, including those considered “waste”, as is the case with wastewater sludge (WWS). The WWS can contain various elements and chemical compounds that can nourish the plants and enrich the soil and its biota, so that they produce food with adequate quality. In addition, as a possible source of energy, WWS can produce methane under specific conditions, the called biogas. But not only that, WWS can also contribute to improving the quality of eroded or degraded soils, in order to increase the production of some crops economically and sustainably.

Discussion

Where do the sludges come from?

They are obtained from the treatment or purification of wastewater of domestic, industrial or storm origin, among others, or from the combination of all of them. During primary treatment, WWS or biosolids are obtained by chemical flocculation through the addition of polymers and subsequent sedimentation, thickening and separation of water, as one example. Therefore, each sludge is different from another, even with respect to time. So, there are opportunities for do research in order to take advantage of the organic matter and minerals present in the sludge that could be useful as possible nutrients for plants and countless microorganisms of various species with high biotechnological potential for solve some problems or solutions as to produce biogas or restore damaged soils, or cultivate plants, all of them with beneficial effects for the environment.

Final disposal of wastewater sludge

The management of the WWS is one of the difficulties faced by the wastewater treatment plants (WWTP), because they involve the collection, storage or final disposal of the WWS. Some

WWTP can generate more than 1,500 tons (1 500,000 kg) of WWS per month, so it is very important to develop technologies to take advantage of WWS. Currently, WWS is confined in landfills, stored in gigantic tanks or incinerated, and rarely used as a substrate or soil improver. However, before bringing the WWS to final disposal its physical, chemical or biological properties must be modified in order to reduce its volume, immobilize or eliminate toxic, eliminate biological agents and achieve health security with low levels of risk to man and the ecosystem.

Uses and waste

Although WWS are waste materials, sludge could have potential uses, but in some countries their use is limited mainly due to ideological positions or lack of research, who without sufficient knowledge say they are concerned about the content of heavy metals, toxic compounds or pathogens. Certainly, the WWS could contain heavy metals, toxic compounds or enteropathogenesis, but there are several cutting-edge technologies to characterize, manage and reduce the pathogens or toxic compounds, so that the WWS are harmless and of quality for various purposes.

WWS application to the soil

Some researchers have reported that, some WWS can significantly favour the development of various crops such as fodder corn, cauliflower, alfalfa, sunflower, among others. In addition, the effect of WWS on the emission of greenhouse gases in agricultural soils has also been determined. In this sense, in an agricultural soil it was determined that nitrous oxide (N_2O ; a greenhouse gas) increases when WWS is added [1,2]. However, after various statistical analyses it was revealed that despite the fact that WWS increase N_2O emissions, crops grow much better with WWS, compared to those without fertilizers or even better than those fertilized with urea (the most widely used chemical fertilizer in the world) despite emitting a significant amount of pollutants during its synthesis and use. Additionally, it has been reported that WWS favour bioremediation of soils contaminated with hydrocarbons through stimulation, accelerating the removal of polycyclic aromatic hydrocarbons [3] because the abundance and diversity of microorganisms and the high content of easily degradable organic matter they contain are used the WWS.

Use alternatives

With advances in research, alternatives have emerged in the treatment of WWS, in order to obtain a product or by-products in important fields such as food, construction and energy production (heat, electricity or biofuel). Regarding food, some studies have shown that about WWS favour the development of crops and improve the physical and chemical properties of soils [4]. The above is an important advantage, compared to chemical fertilizers, which do favour crops, but due to improper application and excessive use, they have degraded and eroded agricultural soils. In addition, WWS can be used as organic material to produce composts or vermicompost, as soil improvers or as a substrate for a wide variety of ornamental plants and trees. Even WWS could be enriched with

countless microorganisms that have the ability to promote plant growth, regulate the incidence of pathogens or reduce the demand for chemical fertilizers. That is, WWS could be a cheap and reliable vehicle for transporting and depositing beneficial microorganisms on the ground.

In cases where WWS are incinerated, their ashes have various uses in construction, for example, to improve the physical properties of cement and concrete, or to increase the strength of the bricks and/or improve their thermal properties, and sludge can be a replacement of sand because the mineral addition improves the parameters tested [5]. According to Garcés et al. [6], they found that cement was considered ideal for preparing mortars containing ashes from WWS due to exhibits moderate pozzolanic activity and the highest compressive strengths. On the other hand, Vall et al. [7], tested several specimens of concrete using different percentages of sludge searching the physical properties as density, porosity, and absorption capacity and mechanical properties as compressive strength, flexural strength, and elastic modulus, over time. The results were that up to 10% of sludge can be added to concrete for reach cement that can be used for road bases and subbases, and as a filling material. Energy recovery and nutrient reuse from WWS has been achieved via anaerobic digestion and power generation with soil application of this one [8], but pyrolysis (thermal processes) have typically been used only for energy recovery. They found that there is potential to use pyrolysis as an effective means to recover and reuse both the energy and the very valuable phosphorus present in WWS.

Conclusion

The WWS considered as waste, take a crucial role seen as an abundant source of nutrients and organic matter with agricultural importance, as well as a renewable energy source. However, to be incorporated into soils and crops of interest, it is extremely important to carry out a complete and detailed study regarding their characterization and management to offer a safe, quality material that has the ability to convert the 'waste' into 'a way or means of well-being'. Clearly, much remains to be investigated, but the search for new technological alternatives must continue, in order to take full advantage of the WWS to contribute to food production, the use of renewable energy sources, environmental care, and the promotion of social and economic well-being.

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To Instituto Politécnico Nacional and Cinvestav Unidad Saltillo.

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