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The Circular Economy as Basis of Sustainability and Efficiency Concerning the Management of Swine Wastewater

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Abstract

The circular economy consists of converting waste into resources that can be reincorporated to the production system. The present study analyzed the recovery of energy, water and nutrients from the anaerobic digestion of swine wastewater.

Keywords: Circular economy; Anaerobic digestion; Biogas; Energy; Reuse

Introduction

The unsustainable current energy models highlight the limited potentials of conventional energy resources, as well as the environmental degradation resulting from its own application. Energy consumption in the developed countries has increased by 1-5% per year. According to the European Commission, current energy needs of the European Union are met at 50% with imported products, unit that could rise up to 70% in the next twenty or thirty years.

In light of this, the concept of circular economy is introduced. The circular economy consists of an industrial economy that is restorative by intention. This aims to rely on renewable energies, minimize energy use, eliminate the use of toxic chemicals and eradicate waste through a careful design [1]. Europe needs a new economic system that takes care of the environment, does not contribute to the pollution and does not waste more resources than we have. In this regard, a sustainable system must be established through the implementation of the circular economy [2].

Consequently, the circular economy is connected to new sustainable strategic developments that want to invest in renewable resources in developing countries. It is recognized that a circular economy reforms environmental management and helps the sustainable development [3]. According to Liu et al. [4] the circular economy has two dimensions: practical and theoretical. In the practical aspect, the circular economy attempts to reduce waste and protect the environment. This aspect follows the "3R principle": reduce, reuse and recycle materials and energy. On the other hand, the theoretical circular economy has the premise that we live in an earth with limited resources and environmental capability. Thus, the objective of the circular economy is to reduce the lineal flow of materials and do it more balanced with the ecosystem.

The livestock manure´s impact on the environment is one of the major challenges in the field of agriculture [5]. Manure derived from swine wastewater was initially used to provide organic matter and nutrients to soil and improve its properties regarding the development of crops. However, the high amount of swine wastewater coming from the swine production facilities makes the management of this effluent difficult, causing a severe impact on the environment. Piggery effluents can pollute soil, water and air quality, as well as the threat to human and animal health [6,7].

The concept of circular economy was applied to swine wastewater with the aim of recovering the resources contained in this effluent such as water, nutrients and energy.

Materials and Methods

The study was carried out in a wastewater treatment plant for the effluents derived from the swine production facilities, located in Jaén (Spain). The application of the circular economy was got through the use of a process consisting of an anaerobic digestion. This biological treatment, which was carried out in absence of oxygen, allowed for obtaining biogas and a liquid-solid fraction called digestate. Figure 1 shows the schematic diagram of the swine wastewater treatment plant used in this study to obtain biogas:

Figure 1: Schematic diagram of the swine wastewater treatment plant to obtain biogas.

Results and Discussion

The biogas enabled the generation of energy which could be used in the own wastewater treatment process. In particular, the biogas production involved a reduction between 5% and 10% concerning the use of natural gas. The digestate made the production of fertilizer and water possible [8]. The fertilizer obtained in the process carried out in this research could be used in agriculture as contained nitrogen, phosphorus and potassium, and does not have pathogens. The water that was recovered from the process of anaerobic digestion could be reused in the treatment process as refrigeration water or could be used for irrigation in agriculture.

Conclusions

Swine wastewater could be considered as a resource that was reincorporated to the production system, enabling the recovery of energy, water and nutrients contained in it.

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