Radiation application for environmental pollution prevention and resource recovery

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The amount of livestock wastewater gradually increases each year with the increase of consumption of livestock products. Livestock wastewater contains high concentrations of organics, nitrogen and phosphorus, and some micropollutants such as antibiotics. Therefore, the discharge of untreated livestock wastewater can cause some serious environmental problems such as a groundwater and soil contamination, an eutrophication of water stream, and an ecosystem disturbance by antibiotic-resistant microbes. Thus, many researchers have focused on the development of various treatment techniques including traditional biological treatment methods. Besides, the recycling of livestock waste has been studied for a resource recovery. Livestock waste and wastewater can be used as organic fertilizer for soil improvement with an increase of crop yield using compost and liquid fertilizer instead of chemical fertilizer. However, these methods include many problems, such as a high loss rate of nitrogen, emission of CO_2, high operating and maintenance costs, low coefficient of utilization of nutrients and groundwater pollution due to the fast release of livestock liquid fertilizer.

Hydrogels have been used as polymeric materials due to their unique properties such as water absorbency, adsorption, and controlled release. They are widely applied in many fields, such as tissue engineering, enzyme biosensor, wound dressing, biomedicals and drug delivery so on. In addition, they have been applied for the adsorption of dyes and the removal of metal ions in the industrial wastewater. However, no report has been found for the recycling of livestock wastewater as a soil fertilizer through the recovery of nutrient ions using a hydrogel.

In this study, three kinds of hydrogel were synthesized, and the physicochemical properties were investigated when they were exposed to livestock wastewater. Hydrogels based on polysaccharide materials, i.e., carboxymethyl cellulose-Na (CMC), carboxymethyl-starch (CMS) and carboxymethyl-chitosan (CMCTS), were synthesized by gamma ray crosslinking. They were characterized in terms of gelation, swelling and ion adsorption. Among the various hydrogels, CMC had the highest swelling ratio and ion adsorption capacity. The order of NO_3^- adsorption amount was found to be CMC > CMS > CMCTS. This study showed that a hydrogel crosslinked by radiation can be applied to an alternative technique instead of a conventional liquid fertilizer. It can reduce the pollutant load with the recovery of nutrient ions from untreated livestock wastewater.