Recovery of Value-Added Products from Swine Manure and Waste Peaches

Matias Vanotti, Ariel Szogi, Raul Moral, and William Brigman

U.S. Department of Agriculture, Agricultural Research Service (USDA-ARS), Coastal Plains Soil, Water and Plant Research Center, Florence, South Carolina, USA.

E-mail: matias.vanotti@usda.gov

Abstract. A new approach for the recovery of value-added products from wastes is to search for a synergistic effect from combining two or more wastes. This work improved the recovery of phosphorus and proteins from swine manure by adding a second waste to the manure: fruit waste. The second waste rich in sugars acted as a natural acid generator that replaced the use of purchased acids and lowered the overall recovery cost. In this study, the two model wastes were: swine manure solids (source of extractable phosphorus and proteins) and waste peaches (peaches that were too soft, had bad spots, or did otherwise not meet the grade for sale as fresh fruit). The new process was patented by USDA (US Patent No. 10,710,937). The phosphorus was precipitated with calcium or magnesium compounds, obtaining concentrated phosphate products with more than 90% plant-available phosphorus. The proteins in the manure were separated in a second step. The process recovered > 80% of the phosphorus and proteins in the manure It is contemplated that other sugar-containing agricultural products, such as other fruits and vegetables, could be used in this process for the same purpose with minor adjustments for amounts depending on the sugar concentration and initial pH of the fruit or vegetable.

Keywords: Wastes, Swine Manure, Model Wastes, Phosphorus, Proteins

Introduction

A new approach for recovering nutrients and value-added products from waste is to search for a synergistic effect from combining two or more wastes. This work improved the recovery of phosphorus and proteins/amino acids from swine manure by adding a second waste to the manure: fruit waste. The second waste rich in sugars acted as a natural acid generator that replaced the use of purchased acids and lowered the overall cost of recovery) (Figure 1).

Methodology

A new approach was developed to separate and recover concentrated phosphorus and proteins from animal waste (Vanotti and Szogi, 2019). It was improved by adding a second waste or product containing sugars, such as molasses and fruit waste (Vanotti et al., 2020). They could be used as a natural acid precursor that replaces the use of purchased acids and lowers the overall cost of phosphorus and protein recovery. In this study, the two model wastes were: swine manure solids (source of extractable phosphorus and proteins) and peach waste (source of acid precursors).

G. Uzochukwu et al. (eds.), *Proceedings of the National Conference on Next-Generation Sustainable Technologies for Small-Scale Producers (NGST 2022)*, Advances in Biological Sciences Research 34,
https://doi.org/10.2991/978-94-6463-282-8_6

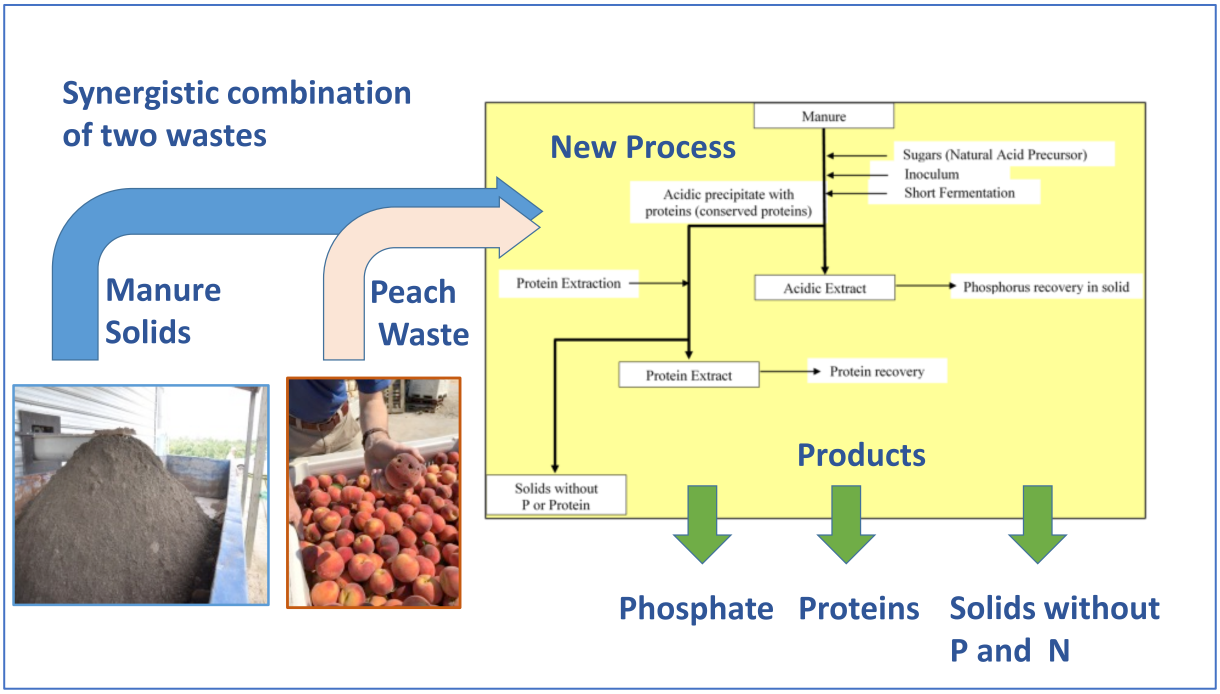

Fig. 1. Pictorial summary of the new approach for recovering phosphorus and proteins from manure using fruit wastes (Vanotti et al., 2020).

Results

On a dry-weight basis, the swine manure solids contained high amounts of proteins (15.2%) and phosphorus (2.9%) available for extraction. It was shown that waste peaches, an abundant waste in SE USA with no cost, contain about 8% total sugars and can be used as an acid precursor to effectively extract phosphorus and proteins from swine manure (waste peaches were peaches that were too soft, had bad spots, or did otherwise not meet the grade at the Processing Plant for sale as fresh fruit). The waste peaches were added to the manure, and the combo received rapid fermentation (24-h) after adding an inoculum consisting of a *Lactobacillus acidophilus* suspension (Vanotti et al., 2020). The sugar profile of waste peaches (g per 100 g fresh weight) was: total sugars = 8.41 g, fructose = 1.78 g, glucose = 2.27 g, sucrose = 4.25 g, and brix grade = 7.7 deg. The peach material added substantial sugars to the mixture but little P and proteins; at the highest treatment, the peach material added 12.4% and 5.7% to the amount of protein and P in the original manure, respectively. The addition of fruit waste to the manure and rapid fermentation produced abundant natural acids - lactic acid, citric acid, and malic acid – that effectively solubilized the phosphorus in the manure (Figure 2). The acid composition of the acidic extract after fermentation was: lactic acid = 11950 mg/L, citric acid = 1190 mg/L, and malic acid 400 mg/L. Further, the peach fermentation did not adversely affect the protein recovery from the manure. A pH of about 5 or less is a useful target to optimize the phosphorus and protein recovery from manure. The target was successfully met using a variety of natural acid precursors (fructose, molasses, and peaches). The phosphorus was precipitated with calcium or magnesium compounds, obtaining concentrated phosphate products with > 90% plant-available phosphorus. The process recovered > 80% of the P and proteins/amino acids in the manure (Vanotti et al., 2020). It is appreciated that peaches are not the sole fruit or food waste product (i.e., vegetables) that contains significant amounts of sugar. It is contemplated that other sugar-containing agricultural products, such as other fruits and vegetables, could be used in this process for the same purpose with minor adjustments for amounts depending on the sugar concentration and initial pH of the fruit or vegetable.

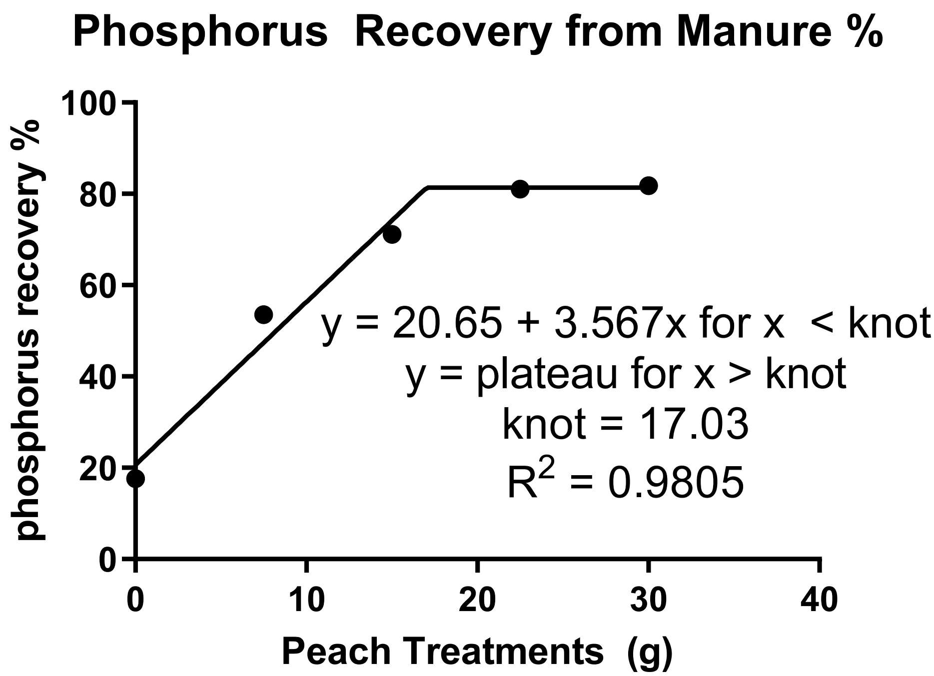

Fig. 2. The addition of peach waste to the manure and rapid fermentation significantly increased phosphorus recovery from the manure, up to a plateau recovery (Vanotti et al., 2020).

Conclusion

The synergistic combination of two wastes to enhance the recovery of phosphorus and protein products could be a potential new revenue stream from waste. The co-recovery of phosphorus and proteins from two wastes could be advantageous to offset treatment and storage costs and lessen land application's environmental impacts. The recovered proteins can produce amino acids, and the recovered phosphorus can be used as a recycled material that replaces commercial phosphate fertilizers.

References

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