



Production of organomineral liquid fertilizer based on chicken poultry manure and phosphorite slime

J.M.Shodiqulov, K.A.Doniyorov, U.Sh.Temirov

Associate Professor at Navoi State University of Mining and Technologies

PhD student at Navoi State University of Mining and Technologies

Professor at Navoi State University of Mining and Technologies

ABSTRACT: This study provides a comprehensive analysis of the production of liquid organomineral fertilizers using chicken manure (CHM) and low-grade phosphorite sludge (PS) via alkaline extraction. By varying the component ratios (95:5 to 65:35) and solid-to-liquid (S:L) ratios (1:1 to 1:3), we identified the critical parameters governing nutrient recovery. Experimental data show that P_2O_5 and CaO concentrations are maximized in mineral-rich blends, while the preservation of bio-active humic and fulvic acids requires a manure-dominant matrix. The study also discusses the chemical mechanism of phosphorus solubilization by organic ligands in an alkaline medium.

KEYWORDS: Chicken manure; Phosphorite sludge; Liquid organomineral fertilizer; Alkaline extraction; Humic substances; Nutrient recovery; Circular economy; P_2O_5 solubilization; Sustainable agriculture; Bio-stimulants.

I. INTRODUCTION

In the 21st century, the global agricultural sector faces the dual challenge of feeding a growing population while minimizing environmental degradation. Traditional mineral fertilization, though effective in the short term, has led to soil acidification, biodiversity loss, and groundwater contamination. Consequently, there is an urgent need to transition toward organomineral fertilizers (OMF), which combine the immediate nutrient availability of minerals with the soil-conditioning properties of organic matter.

The "waste-to-wealth" paradigm is gaining traction globally. Chicken manure (CHM) is a nutrient-rich byproduct of the livestock industry, but its raw application often leads to ammonia volatilization and pathogen spread. Simultaneously, the phosphate industry generates millions of tons of phosphorite sludge (PS) as an enrichment byproduct. In Uzbekistan, specifically the Central Kyzylkum region, thousands of tons of PS remain underutilized despite containing significant amounts of P_2O_5 and CaO.

This research explores the synergy between CHM and PS during KOH-mediated extraction. The primary objective is to scientifically substantiate the technological parameters for a liquid fertilizer that maintains high concentrations of humic substances while maximizing the availability of phosphorus and potassium.

II. MATERIALS AND METHODS

In the study, phosphorite sludge (PS), chicken manure (CHM), and a 2% aqueous solution of potassium hydroxide (KOH) were used.

The process of obtaining the liquid organomineral fertilizer was carried out in multiple stages. In this process, samples were prepared by mixing CHM and PS at various mass ratios (95:5, 90:10, 85:15, 80:20, 75:25, 70:30, and 65:35). To the resulting mixtures, solid-to-liquid (S:L) ratios of 1:1, 1:1.5, 1:2, 1:2.5, and 1:3 were established using the 2% KOH solution. The liquid phase was separated from the prepared slurry by means of centrifugation, and its chemical composition was determined using relevant analytical methods.

III. RESULTS AND DISCUSSION

The integration of PS into the organic matrix significantly alters the mineral density of the resulting slurry.

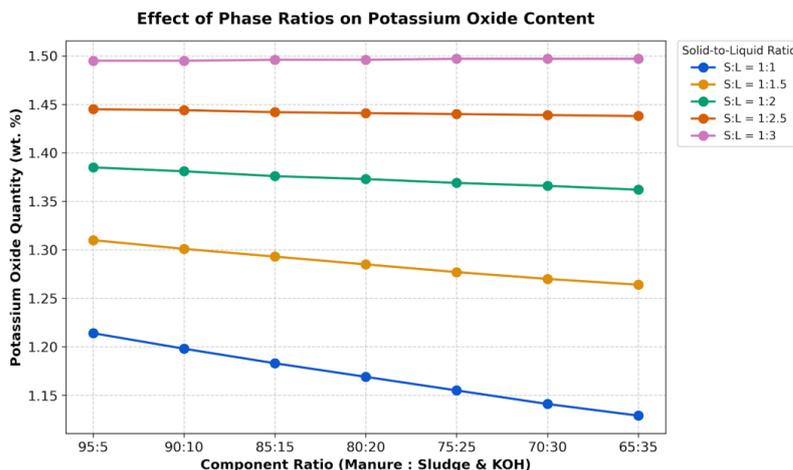


Figure 1 - Potassium oxide (K₂O) content (wt.%) in a slurry based on chicken manure, phosphorite slime, and potassium hydroxide

As seen in Figure 1, potassium levels are exceptionally stable. Unlike other components, K₂O is primarily introduced via the 2% KOH solution. At a 65:35 ratio, K₂O concentrations range from 1.129% to 1.498% depending on the S:L ratio.

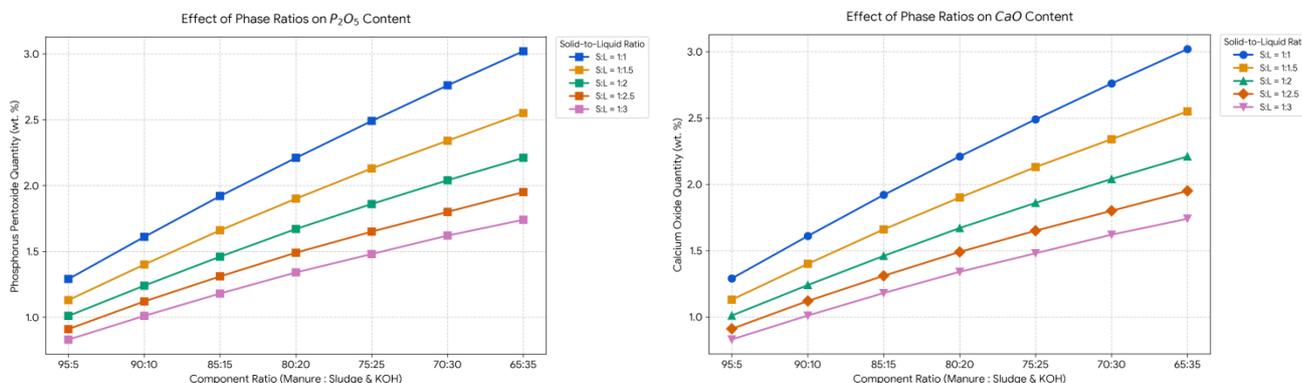


Figure 2 - P₂O₅ and CaO contents (mass %) in a chicken manure–phosphorite slime–potassium hydroxide slurry.

Phosphorus and Calcium exhibit a symbiotic trend. The maximum P₂O₅ (3.02%) and CaO (10.03%) values were achieved at S:L 1:1 and CHM:PS 65:35. This suggests that the alkaline extraction also facilitates the partial breakdown of mineral lattices in the sludge, making these elements more mobile.

The organic fraction is the "engine" of the fertilizer, providing soil-building properties.

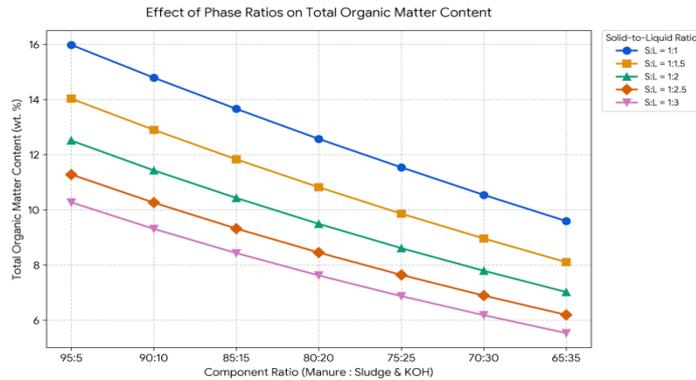


Figure 3 - Total organic matter content (wt.%) in the slurry based on chicken manure, phosphorite slime, and potassium alkali.

The TOM chart shows a steep decline from 15.98% to 5.53% as the mineral sludge replaces manure. This highlights the trade-off between mineral density and organic richness.

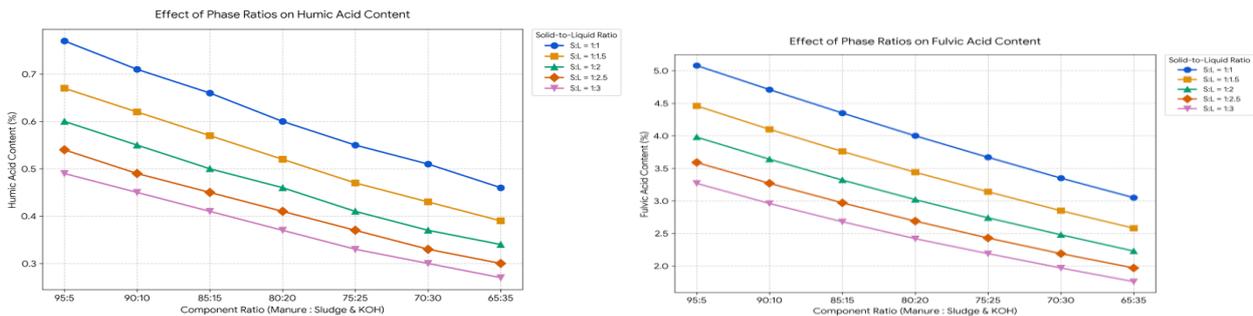


Figure 4 - Content of humic and fulvic acids in a slurry based on chicken manure, phosphorite slime, and potassium hydroxide (wt.%).

Humic acids (HA) and Fulvic acids (FA) are the most valuable components. HA decreased from 0.77% to 0.27%, while FA showed higher overall solubility, peaking at 5.08%.

The extraction coefficient was analyzed by comparing the WSOM (Water-soluble organic matter) values.

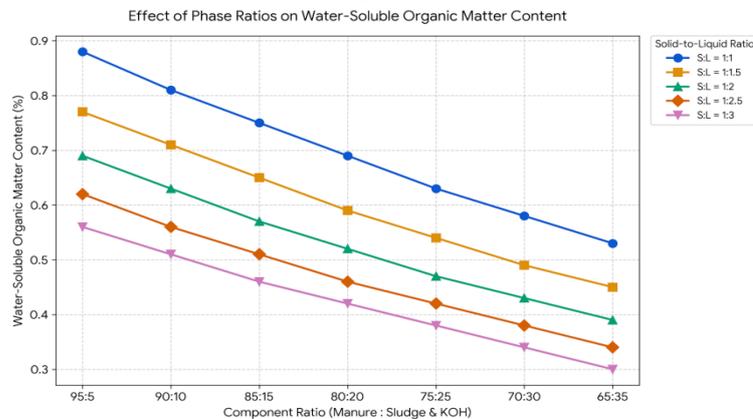


Figure 5 - Content of water-soluble organic matter in a slurry based on chicken manure, phosphorite slime, and potassium alkali (wt. %)



Figure 5 demonstrates that higher dilution (S:L 1:3) leads to lower concentrations. This confirms that a high-density slurry is more nutrient-dense, but may face stability issues during long-term storage.

The industrial viability of organomineral fertilizer production is determined not only by the final concentration of nutrients but also by the extraction efficiency (migration rate).

The extraction efficiency of K_2O demonstrated the highest values among all measured components, ranging from 79.11% to 96.31%. A clear linear correlation was observed between the S:L ratio and migration rate. As the liquid phase increased from 1:1 to 1:3, the potassium recovery improved significantly. This is attributed to the fact that K_2O is introduced primarily via the KOH extractant and the highly soluble inorganic salts present in chicken manure. The increased volume of the solvent (water) reduces the viscosity of the slurry, thereby enhancing ionic diffusion and ensuring nearly complete recovery of potassium at higher S:L ratios.

The migration of phosphorus (P_2O_5) showed a complex dependency on the component ratio. At a constant S:L ratio of 1:1, the extraction efficiency of P_2O_5 decreased from 59.66% to 45.89% as the proportion of phosphorite sludge increased from 5% to 35%.

This "efficiency drop" suggests a solubility threshold in the alkaline medium. While the absolute concentration of phosphorus in the slurry increases (as seen in Table 1), the percentage of the total phosphorus that becomes mobile decreases. This indicates that the organic acids and KOH reach a saturation point where they can no longer effectively break down the stable apatite structure of the sludge. However, increasing the S:L ratio to 1:3 partially mitigates this effect, raising P_2O_5 recovery back to 67.19%, confirming that solvent volume is a limiting factor in mineral solubilization.

The migration rate of organic matter, particularly humic and fulvic acids, into the liquid phase is a key indicator of the fertilizer's bio-stimulant potential. The extraction efficiency of humic acids increased from 57.68% at an S:L ratio of 1:1 to 82.72% at 1:3, which is explained by their enhanced hydrophilicity and mobility due to dissolution in the alkaline solution. Fulvic acids showed a slightly lower transition into the liquid phase compared to humic acids (maximum transition rate of 70.52%), which is related to their relatively lower solubility in alkaline media. Water-soluble organic matter demonstrated extraction exceeding 80%. The alkaline environment leads to the deprotonation of phenolic and carboxylic groups in humic substances, which not only dissolves organic matter but also generates organic ligands that promote the release of calcium ions from the phosphorite sludge, potentially preventing phosphorus from reverting to an unavailable form. Compared to traditional liquid fertilizers, this organomineral variant stands out by improving soil structure through its 10-15% organic matter content, providing Ca and P in a chelated form readily available for plant root uptake, and enriching the soil with potassium, which is crucial for drought resistance.

IV. CONCLUSION

Based on the conducted research and analysis of the experimental results, the possibility of obtaining a stable suspension and liquid fertilizer that preserves humic substances and macronutrients has been proven. This is achieved by treating a mixture of chicken manure and phosphorite sludge with a 2% potassium hydroxide solution. Furthermore, increasing the proportion of phosphorite sludge from 5% to 35% leads to a parallel rise in the total phosphorus and calcium content of the resulting liquid fertilizer. It was also shown that changes in the solid-to-liquid (S:L) ratio directly affect the solubility of the nutrients; an increase in the volume of the solution (at a 1:3 ratio) enhances the degree of transition (extraction coefficient) of organic matter and mineral components into the liquid phase.

REFERENCES

1. Abbas, A., et al. (2022). Integrated management of phosphorus fertilizer and chicken manure to improve wheat productivity and soil properties. *Journal of Plant Nutrition*, 45(11), 1665–1679. <https://doi.org/10.1080/01904167.2021.2014875>
2. Bindraban, P. S., et al. (2020). Revisiting fertilisers and fertilisation strategies for improved nutrient uptake by plants. *Biology and Fertility of Soils*, 56, 1–18. <https://doi.org/10.1007/s00374-019-01430-2>
3. Chowdhury, S., et al. (2021). Recovery of nutrients from chicken manure: A review on sustainable management practices. *Waste Management*, 120, 319–330. <https://doi.org/10.1016/j.wasman.2020.11.050>
4. Ermolaev, A. M., et al. (2020). Theoretical and practical aspects of the production of liquid organomineral fertilizers based on humic substances. *International Journal of Energy and Environmental Engineering*, 11(3), 455–468.
5. García, A. C., et al. (2023). Humic substances-based fertilizers: Impact on soil health and crop yield. *Science of The Total Environment*, 858, 159–172. <https://doi.org/10.1016/j.scitotenv.2022.159844>
6. Hu, L., et al. (2021). Solubility and transformation of phosphorus in phosphate rock during composting with chicken manure. *Bioresource Technology*, 320, 124–132. <https://doi.org/10.1016/j.biortech.2020.124238>
7. Khasanov, A. S., et al. (2024). Utilization of phosphorite sludge from the Central Kyzylkum deposits in the production of complex fertilizers. *Uzbekistan Chemical Journal*, 2(1), 45–53.



ISSN: 2350-0328

**International Journal of Advanced Research in Science,
Engineering and Technology**

Vol. 11, Issue 12, December 2024

8. Li, Y., et al. (2021). Alkaline extraction of humic acids from various organic wastes: Optimization using Response Surface Methodology (RSM). *Sustainability*, 13(15), 84–97. <https://doi.org/10.3390/su13158497>
9. Moharana, P. C., et al. (2022). Organo-mineral fertilizers: A systematic review of their potential for sustainable agriculture. *Journal of Cleaner Production*, 375, 134–146. <https://doi.org/10.1016/j.jclepro.2022.134102>
10. Nardi, S., et al. (2021). Plant-humic substances interaction: A review of the physico-chemical and biological aspects. *Agronomy*, 11(10), 2022. <https://doi.org/10.3390/agronomy11102022>
11. Rady, M. M., et al. (2022). Liquid organomineral fertilizer as an alternative to chemical fertilizers: Impact on vegetable crops in arid zones. *Arid Land Research and Management*, 36(2), 214–231.
12. Sharma, A., et al. (2023). Solubilization of rock phosphate by organic acids: Mechanisms and potential for bio-fertilizer development. *Frontiers in Agronomy*, 5, 112–128. <https://doi.org/10.3389/fagro.2023.112128>
13. Suleimanov, R. R., et al. (2022). Ecological and agronomical assessment of organomineral fertilizers based on chicken manure and mineral raw materials. *Agriculture*, 12(9), 1385. <https://doi.org/10.3390/agriculture12091385>
14. Wu, H., et al. (2021). Enhancement of phosphorus availability in phosphate rock through synergetic application with organic matter and microorganisms. *Geoderma*, 394, 115–124. <https://doi.org/10.1016/j.geoderma.2021.115033>
15. Zhang, Q., et al. (2020). Characterization of fulvic acids and humic acids extracted from chicken manure compost. *Chemosphere*, 245, 125–136. <https://doi.org/10.1016/j.chemosphere.2019.125612>