A wide variety of odor-controlling compounds is available today. The most common types used are chemical deodorants, which react with the odors to inhibit their release as a gas or to neutralize their unpleasant odors, and digestive deodorants, which contain bacterial cultures or enzymes to control odor production biologically. Research results have been reported for numerous chemicals. Miner (1974) reviewed the use of chemicals like potassium permanganate, hydrogen peroxide and formaldehyde. Cole et al. (1975) found that potassium permanganate was effective in controlling sulfide odors in swine manure at concentrations of 100-500 mg/L. In a recent study, Warburton et al. (1979) tested 22 commercial compounds on swine manure. Overall, they found the performance of the 22 products disappointing.

Several livestock operators have indicated that they have obtained good odor control during application of liquid polyphosphates to the contents of manure tanks. However, no measurements have ever been taken to determine the amount of odor control. A research project was initiated to determine at what rates polyphosphate fertilizer solution would control odors in dairy and swine manure and to compare polyphosphates with several other commercial compounds.

**Experimental Procedures and Results**

A series of five tests using liquid dairy and swine manure was conducted to evaluate odor control by liquid polyphosphates, potassium permanganate, a digestive deodorant, a pesticide wetting agent and zinc-nitrogen liquid fertilizer solution. Polyphosphates and zinc-nitrogen solutions are commercial liquid fertilizers used for crop production. The polyphosphate solution used in the experiments was 10% N and 34% P₂O₅, while the zinc-nitrogen solution was 15% N and 5% Zn. Liquid manure for all experiments was obtained by mixing fresh semisolid swine or dairy manure with water in the 114-L drums to achieve a solids concentration of 5-7%, which is typical of liquid manure tanks. The manure was allowed to stand in the drums for 30-40 days to allow anaerobic conditions to develop before any chemicals were added. All tests were evaluated by an odor panel for odor strength and odor quality. The polyphosphates did not control odors in liquid swine or dairy manure when added shortly after spreading or reduce odors significantly when added at regular intervals. Potassium permanganate at concentrations of 300-500 ppm was the most effective compound tested. The pesticide wetting agent also reduced odors.

In a second series of tests, polyphosphate solution was added at rates of 1, 2, 3 and 4 mL/L to liquid dairy manure in 114-L drums at 10-day intervals. In one set of treatments, the manure was stirred for 2 min while the polyphosphate was added, and in the other set of treatments no stirring occurred. Each treatment was evaluated for odor strength and odor quality 48 h after the initial polyphosphates were added and after 44 days. Before the addition of the polyphosphates and prior to the odor panel evaluations, samples of the unstirred liquid of each treatment were taken for COD, pH and hydrogen sulfide analysis.

After 48 h, none of the polyphosphate treatments reduced the odor presence as measured by odor strength or the offensiveness of the odor as measured by odor quality. After 44 days, the polyphosphate treatments of 1 and 2 mL/L reduced the offensiveness of the odors slightly. At the high-rate treatments, based on the comments of the odor panel, it appears that one type of odor is being eliminated but another odor is replacing it. There appeared to be a slight chemical or swamp-type odor in the high-rate treatments after 44 days. None of the differences in treatment means for odor offensiveness were significant at the 5% level by the Tukey test. The Tukey test is a test used to compare significant differences between treatment means with a single value and the procedure is similar to the LSD test (Steel and Torrie 1960). The chemical oxygen demand (COD), hydrogen sulfide concentration and pH of the different treatments did not change to any extent over the 48-h period.

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little change in the COD concentration or pH of any of the treatments over the 44-day period.

For the third experiment, liquid swine manure was treated in 3.8-L containers with 2 mL/L of polyphosphate solution, 300 ppm of potassium permanganate, 0.26 mL/L of a pesticide wetting agent (Saturall) and a digestive deodorant (Agri-gest) at a rate of 150 ppm. The materials were added 24 h before evaluation by an odor panel. Ritter et al. (1975) found that potassium permanganate and Agri-gest reduced odors in liquid dairy manure. They were used as a comparison to polyphosphates in the third experiment at rates based on earlier testing by the authors. Saturall is a commercial product used for odor control in several States. The recommended loading rates are in the range from 0.13 to 0.26 mL/L.

Both the pesticide wetting agent and potassium permanganate reduced the presence and offensiveness of the odor of swine manure slightly. None of the differences in treatment means were significant at the 5% level.

In the fourth experiment, polyphosphates at rates of 1.0 and 2.0 mL/L, potassium permanganate at 480 ppm and pesticide wetting agent at 0.13 mL/L were added to dairy and swine manure in 114-L containers. Also included was a treatment using nitrogen-zinc liquid fertilizer solution at rates of 1.0 and 2.0 mL/L manure. The polyphosphates, nitrogen-zinc liquid fertilizer and pesticide wetting agent were added weekly for 4 wk, while the potassium permanganate was added 24 h before evaluation by an odor panel.

Both the pesticide wetting agent and potassium permanganate reduced the swine manure odor slightly, while the polyphosphates did not have an effect on the odor. There was no significant difference between the swine manure treatments at the 5% level. None of the treatments had an effect on the dairy manure. Part of this may have been caused by the mild odor of the dairy manure. The pH of all treatments remained relatively constant for the 28-day period while the hydrogen sulfide concentration in the swine manure decreased. The hydrogen sulfide content of the dairy manure was initially low.

In the fifth test, the COD content of the air above swine manure treated in 2000-mL filter flasks with a mixture of 2 mL/L of polyphosphate solution and 2 mL/L of nitrogen-zinc solution, 2 mL/L of pesticide solution, 0.26 mL/L of potassium permanganate and a digestive deodorant was measured. Twenty-four hours after the manure was treated, air was passed through the filter flasks and the COD content of the air was measured for a 16-h period. After 7 days, all flasks except the potassium permanganate treatment were treated again at the initial rates and the COD content of the air was measured. The procedure used was similar to the one developed by Frus et al. (1971).

The potassium permanganate and the mixture of polyphosphate and nitrogen-zinc solution treatments reduced the COD content after 24 h to 5930 and 6660 μg/L air, respectively. The COD of the control was 13 400 μg/L air. The COD of the other treatments did not decrease to any extent. It is not known whether the COD test is an overall measure of the level of organic gases or whether one gas or a combination of gases is predominant.

SUMMARY AND CONCLUSIONS

The odor tests indicate that polyphosphates will not control odors if added shortly before spreading and will not reduce odors significantly if added at regular intervals. Since the polyphosphates did not change the pH of the manure, it does not appear that any other mechanism would cause polyphosphates to control odors.

The pesticide wetting agent, which is currently being used by some swine producers to control odors, will probably cause some reduction in odors in liquid manure. The pesticide wetting agent only reduced the odors slightly in these experiments. The bacteria may have degraded the wetting agent to some extent and limited its odor-controlling capability. The wetting agent probably masks the odors.

Potassium permanganate at concentrations of 300–500 ppm will cause some odor reduction in manure. The results with potassium permanganate were expected, since some earlier research has documented odor control with potassium permanganate (Ritter et al. 1975). Some researchers have also found that potassium permanganate will not control odors in swine manure (Warburton et al. 1979).

Agri-gest, a bacterial deodorant, did not reduce odors in swine manure. The concentration used may have been too low. The mechanism by which bacterial products work is not definitely known. In order for bacterial products to work, the strain of bacteria added to the manure has to become the predominant strain present. In these experiments, the bacterial strain used in Agri-gest may not have reproduced enough to become the predominant strain. Although Agri-gest has been shown to be successful in reducing dairy manure odors, the results of these tests follow the trends reported by other workers using bacteria-based products.

ACKNOWLEDGMENTS

Part of the financial support for this research was provided by Allied Chemical Company, Hopewell, Virginia 23860.


