Jurnal Eduhealth
Volume 15, Number 03, 2024, DOI 10.54209/eduhealth.v15i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

# Determination Of Residual Hazardous Chemical Concentrations In Pharmaceutical Chemistry Laboratory Solid Waste Using Conventional Titration Methods

**Muhammad Nur Abdillah**
Universitas Garut

| Article Info | ABSTRACT |
|---|---|
| **Keywords:**<br>Laboratory Solid Waste,<br>Hazardous Chemicals,<br>Conventional Titration,<br>Residual Concentration,<br>Waste Management | Chemical laboratory waste often contains hazardous chemicals that can pose risks to the environment and human health if not properly managed. This study evaluates the residual chemical concentrations in solid laboratory waste from pharmaceutical chemistry labs using conventional acid-base titration methods. The objective is to determine the exposure levels of acidic and basic chemicals in solid waste and assess the accuracy and precision of the analytical methods. Samples tested included filter paper, wiping cloths, and absorbent cloths, with results showing acidic chemical concentrations up to 0.998 M and basic chemical concentrations up to 0.344 M. The titration method demonstrated high accuracy with recovery percentages of 99.00% for acid addition and 99.50% for base addition, and excellent precision with RSD percentages of 0.02% and 0.04%, respectively. The study recommends separating waste based on chemical type, using appropriate absorbent materials, providing regular training for laboratory personnel, and integrating modern technology into waste management practices. These findings offer critical insights to improve laboratory waste management practices, aiming to minimize environmental impacts and health risks. |
|  | **Corresponding Author:**<br>Muhammad Nur Abdillah<br>Universitas Garut<br>nurabdillah@uniga.ac.id |

## INTRODUCTION

Chemical laboratory waste often contains dangerous chemicals that can pose risks to the environment and human health if not managed properly. Solid waste, in particular, can cause long-term contamination of soil and groundwater, resulting in persistent environmental damage. For example, improper disposal of solid waste containing heavy metals can cause bioaccumulation in the food chain, which risks resulting in neurological damage and organ failure in humans (Smith et al., 2020). Compared with liquid waste, solid chemical waste is more difficult to treat and can persist in the environment for a long time, so effective management and disposal is very important (Jones & Peterson, 2019). Laboratory waste management is an important aspect of sustainable laboratory practices, and is an integral part of efforts to minimize negative impacts on ecosystems and society (Yuan et al., 2021). In the context of pharmaceutical chemistry laboratories, the solid waste produced often contains chemical residues such as strong acids, strong bases and organic solvents that require special handling (Kumar et al., 2020).

Laboratory solid waste, such as filter paper, rags, and other absorbent materials, often receives less attention than liquid waste, even though this solid waste can store dangerous chemical residues that have serious impacts if not managed properly. Chemical residues in solid waste, such as acids and bases, can contribute to soil and groundwater contamination, resulting in the bioaccumulation of toxic substances in ecosystems and food chains, and pose significant health risks, including organ damage and nervous system disorders in humans (Smith et al., 2020). To measure the concentration of chemical residues in solid waste, the conventional titration method is a reliable analytical technique, known for its accuracy in various matrices, including complex ones such as laboratory waste (Davis & Morken, 2019). Therefore, management of solid waste containing hazardous chemicals requires special attention to prevent wider environmental and health impacts.

Titration is a simple but accurate method for determining the concentration of chemicals in a solution. In this study, acid-base titration was used to measure the residual concentration of acids and bases in solid waste. This method involves the use of a titrant reagent that reacts with residual chemicals in the sample until it reaches the end point of the titration, which is then measured to calculate the chemical concentration (Fitzgerald, 2018). The use of conventional titration in this research is designed to provide empirical data that can be used to improve waste management procedures in laboratories.

Previous research has shown the importance of proper waste management in chemistry laboratories to reduce the risk of contamination and environmental impacts (Kumar et al., 2020). However, much of this research focuses on liquid waste and does not discuss solid waste in depth, even though solid waste also has great potential to pollute the environment and pose health risks. Most previous studies emphasize liquid waste management because of its mobile nature and ability to quickly disperse in the aquatic environment, while solid waste is often considered less dangerous because it appears more stable and controllable (Johnson & Walker, 2018). In fact, solid waste with chemical residues can persist for long periods of time and continue to release dangerous contaminants into the environment, which then has a negative impact on ecosystems and human health (Miller et al., 2017). Therefore, greater attention needs to be paid to solid waste management to prevent detrimental long-term effects. Therefore, this study focuses on the analysis of solid waste from pharmaceutical chemistry laboratories, with the aim of providing better insight into chemical residue concentrations and their implications for waste management.

The results of this research are expected to make a significant contribution to the development of better waste management practices in pharmaceutical chemistry laboratories. By determining residual concentrations of chemicals in solid waste and providing recommendations for waste management procedures, this research aims to help laboratories reduce the environmental and health impacts of their chemical waste.

The aim of this research is to determine the residual concentration of hazardous chemicals in pharmaceutical chemistry laboratory solid waste using the conventional titration method. This research aims to evaluate the concentration of residual chemicals present in solid waste, analyze the data to determine potential risks, and provide recommendations for more effective waste management practices.

## METHOD

This research methodology was designed to determine the residual concentration of hazardous chemicals in pharmaceutical chemistry laboratory solid waste using conventional titration methods. The conventional titration method was chosen because this method is proven to have high accuracy and precision in determining the concentration of residual chemicals in solid waste. The procedure begins with collecting solid waste samples from the pharmaceutical chemistry laboratory of Bhakti Sejahtera Pharmacy Vocational School (BSJ), namely, 10 samples of filter paper (5 exposed to acid, 5 exposed to alkali), 4 samples of rags (2 exposed to acid, 2 exposed to alkali), and 2 samples of absorbent cloth (1 exposed to acid, 1 exposed to alkali) which were used to clean up chemical spills (exposed to the acid was HCl and the base was NaOH) during laboratory practicum. The blank comparison samples prepared were 1 each for each type of unexposed/new sample. All samples were then dried at 60°C for 24 hours and ground into fine powder using a chopper and solid/fabric grinder. Each sample powder was dissolved in the appropriate solvent, namely distilled water with a ratio of 1 g of powder per 100 mL of solvent. The extraction solution in each container is labeled and then used for titration (Davis & Morken, 2019).

Titration was carried out using a prepared titer, namely NaOH 0.1 N and HCl 0.1 N for acid-base titration whose concentration had been standardized (NaOH was standardized with 0.1 N H2C2O4, HCl was standardized with Na2B4O7.10H2O). The phenolphthalein indicator is used for base titrations, and the methyl orange indicator for acid titrations. Titration of the sample solution exposed to acid was titrated with a base pentiter and the sample solution exposed to base was titrated with an acid pentiter. Each sample solution was tested in three replications and the volume of pentiter used was recorded for calculating the residual concentration of chemicals in solid waste. The data obtained is then processed and the average residual chemical concentration is determined (Fitzgerald, 2018; Kumar et al., 2020). The titration treatment is followed by determining the accuracy and precision of the analysis method. Determining accuracy using the acid addition and base addition methods for blank samples of filter paper, rags and absorbent cloth, to obtain the percent recovery. Determination of precision was carried out using the interday precision technique with 6 replications using the acid addition and base addition methods for filter paper blank samples to calculate the percent RSD.

**Table 1.**Samples and Labeling

| | Filter Paper | | Duster | | Absorbent Cloth | |
|---|---|---|---|---|---|---|
| | Amount | Code | Amount | Code | Amount | Code |
| Exposure to Acid | 5 | KSA | 2 | KLA | 1 | KPA |
| Exposure to Alkaline | 5 | KSB | 2 | KLB | 1 | KPB |
| Blank | 1 | KSO | 1 | KLO | 1 | KPO |

Jurnal Eduhealth
Volume 15, Number 03, 2024, DOI 10.54209/eduhealth.v15i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

Note: Sample numbering according to the code and number of samples per type, for example KSA1-KSA5, KLA1-KLA2, KPA1, etc.

## RESULTS

### Sample Preparation

The sample preparation process begins with the collection of solid waste from the pharmaceutical chemistry laboratory, including filter paper, rags, and absorbent cloth as listed in Table 1. These samples are then dried at 60°C for 24 hours to ensure that all moisture has been removed. removed before milling and crushing to a fine powder. The resulting powder is then dissolved in distilled water as a solvent, producing a sample solution that is ready for analysis. To ensure accuracy in the titration process, the 0.1 N NaOH and 0.1 N HCl pentiter solutions were standardized using appropriate primary standards, with the standardization results showing that the pentiter concentration was within the expected range with minimal deviation, data can be seen in Table 2. Thus, the prepared sample and titer solutions are ready to be used for the next titration stage, ensuring the reliability of the analysis results.

**Table 2.**Pentiter Standardization Results

| | Titer NaOH with 0.1 N H2C2O4 | | HCl titer with Na2B4O7.10H2O 0.1 N | |
|---|---|---|---|---|
| | Volume of NaOH (mL) | N NaOH Calculate | Volume of HCl (mL) | N HCl Calculate |
| Replication 1 | 9.85 | 0.102 | 10,10 | 0.099 |
| Replication 2 | 9.90 | 0.101 | 10.15 | 0.098 |
| Replication 3 | 9.90 | 0.101 | 10.05 | 0.099 |
| | Average | 0.101 | Average | 0.099 |

### Determination of Residual Concentration

Determination of blank samples is carried out to ensure that any external influences or contaminants that may be present in the solvent or equipment do not affect the titration results. Blanks were made by following the same procedure as the main sample, but without the expected residual chemicals, so this research used fresh samples. The titration results on blank samples show that the volume of titrant reagent required to reach the end point is very small and is within negligible limits, indicating that the influence of contamination or experimental error is minimal. Therefore, the correction value of this blank sample is calculated and will be applied as a correction factor in the titration analysis of the main sample, ensuring the accuracy and validity of the results obtained. The results of determining blank samples can be seen in Table 3.

**Table 3**. Blank Sample Determination Results

| Volume in mL | KSO1 | | KLO1 | | KPO1 | |
|---|---|---|---|---|---|---|
| | Vol NaOH | Vol HCl | Vol NaOH | Vol HCl | Vol NaOH | Vol HCl |
| Replication 1 | 0.10 | 0.00 | 0.00 | 0.20 | 0.20 | 0.25 |
| Replication 2 | 0.10 | 0.00 | 0.00 | 0.20 | 0.20 | 0.25 |
| Replication 3 | 0.10 | 0.00 | 0.00 | 0.20 | 0.20 | 0.25 |
| Average | 0.10 | 0.00 | 0.00 | 0.20 | 0.20 | 0.25 |

Description: Blank NaOH volume is used to reduce the NaOH volume for base titrations.
Blank HCl volume is used to reduce the acid titration volume

The values in Table 3 from the blank sample determination results will be used as correction factors in the main sample titration analysis, namely, the volume of NaOH used in the base titration will be subtracted from the blank determination results and the HCl volume in the acid titration will be subtracted from the blank determination results, and This value is used in the calculation of each type of sample. This correction aims to eliminate the influence of external variables detected in the blank sample, so that the final results are more accurate and reliable.

**Table 4.**Results of Determining Samples Exposed to Bases

| Sample | Average Vol HCl | N Count | Sample | Average Vol HCl | N Count | Sample | Average Vol HCl | N Count |
|---|---|---|---|---|---|---|---|---|
| KSB1 | 20.00 | 0.198 | KLB1 | 12.80 | 0.127 | KPB1 | 34.75 | 0.344 |
| KSB2 | 24.10 | 0.238 | KLB2 | 8.30 | 0.082 | | | |
| KSB3 | 18.50 | 0.183 | | | | | | |
| KSB4 | 25.00 | 0.248 | | | | | | |
| KSB5 | 22.50 | 0.223 | | | | | | |
| Average | | 0.218 | | | 0.105 | | | 0.344 |
| Interpretation | | Currently | | | Currently | | | Currently |
| Information | | Volume in mL<br>Sample Volume 10.00 mL<br>N Calculation = (Average Vol HCl x N HCl Standardization) / 10.00 mL<br><0.1 N: Low Chemical Exposure<br>0.1-0.5 N: Medium Chemical Exposure<br>>0.5 N: High exposure to chemicals | | | | | | |

The results of determining residual alkaline concentrations in various types of solid waste samples (Table 4) indicate exposure to alkaline chemicals in the medium category. For filter paper samples, the average measured base concentration was 0.218 N. This value indicates that the filter paper has been exposed to a significant amount of alkaline chemicals, but is still in the moderate category, which indicates the need for special attention in managing this waste. to prevent potential environmental or health hazards.

Jurnal Eduhealth
Volume 15, Number 03, 2024, DOI 10.54209/eduhealth.v15i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

Meanwhile, samples of rags and absorbent rags also showed exposure to alkaline chemicals with average concentrations of 0.105 N and 0.344 N respectively. Even though the concentration on rags was lower, it was still in the medium category, indicating exposure to chemicals. which is quite significant. On the other hand, the absorbent cloth had the highest base concentration among the three types of samples with 0.344 N, which is also in the medium category. These results indicate that absorbent fabrics tend to absorb more alkaline chemicals, so they require special management to prevent the negative impacts of this waste. Overall, these three types of samples indicate exposure to alkaline chemicals that need to be handled with appropriate waste management procedures so that environmental and health risks can be minimized.

**Table 5.**Results of Determining Samples Exposed to Acid

| Sample | Average Vol NaOH | N Count | Sample | Average Vol NaOH | N Count | Sample | Average Vol NaOH | N Count |
|---|---|---|---|---|---|---|---|---|
| KSA1 | 49.90 | 0.504 | KLA1 | 70.00 | 0.707 | KPA1 | 98.80 | 0.998 |
| KSA2 | 36.40 | 0.368 | KLA2 | 80.50 | 0.813 | | | |
| KSA3 | 65.40 | 0.661 | | | | | | |
| KSA4 | 62.00 | 0.626 | | | | | | |
| KSA5 | 55.50 | 0.561 | | | | | | |
| Average | | 0.544 | | | 0.760 | | | 0.998 |
| Interpretation | | Tall | | | Tall | | | Currently |
| Information | | Volume in mL<br>Sample Volume 10.00 mL<br>N Calculation = (Average Vol NaOH x N NaOH Standardization) / 10.00 mL<br><0.1 N: Low Chemical Exposure<br>0.1-0.5 N: Medium Chemical Exposure<br>>0.5 N: High exposure to chemicals | | | | | | |

The results of determining the residual acid concentration in solid waste samples from the pharmaceutical chemistry laboratory showed exposure to acidic chemicals in the high category in all types of samples tested (Table 5). In the filter paper type samples, the average acid concentration measured was 0.544 M. This concentration indicates that the filter paper has been exposed to significant amounts of acid, so it requires special attention in handling and management. High acid exposure to filter paper can increase the risk of corrosion and other hazards if not handled properly.

For the rag type samples, the analysis results showed that the average acid concentration reached 0.760 M. This value was higher compared to filter paper, indicating that the rags had a greater ability to absorb acid or may have been used in situations involving acid concentrations. higher. Exposure to high levels of acid in rags indicates the need for stricter waste management procedures to prevent dangerous impacts on the environment and human health.

The absorbent cloth type samples showed the highest acid concentration among the three types of samples, with an average concentration reaching 0.998 M. The acid exposure on this absorbent cloth was on the threshold of the high category, which indicates that the cloth had absorbed a very significant amount of acid. This condition indicates that the absorbent fabric is very susceptible to acid exposure and requires extra careful handling to avoid the risk of further contamination or damage to other equipment that may come into contact with this waste. Overall, these three sample types indicate exposure to high concentrations of acidic chemicals, which demands appropriate management and disposal procedures to minimize risk.

**Accuracy and Precision of Analysis Methods**

**Table 6.** Accuracy and Precision Data of Analysis Methods

| Accuracy (% Recover | | |
|---|---|---|
| Blank Addition Method | Acid Addition | Base Addition |
| Filter Paper Samples | 99.10 | 99.20 |
| Duster Samples | 99.00 | 99.50 |
| Absorbent Fabric Samples | 98.90 | 99.70 |
| Average | 99.00 | 99.50 |
| Interday Precision (% RSD) 6 replications of filter paper blank samples | | |
| Acid Addition | | Base Addition |
| 0.02 | | 0.04 |

The results of evaluating the accuracy and precision of the conventional acid-base titration method show excellent performance in sample analysis. For accuracy, the acid addition and base addition methods on filter paper blank, rag and absorbent cloth samples, averaged per addition method, gave a percent recovery of 99.00% and 99.50%, respectively, which indicates that the method it is capable of measuring chemical concentrations with a very high degree of accuracy, almost close to the actual value. The precision of this method also shows very satisfactory results, with a percent RSD for interday precision of 0.02% for acid adducts and 0.04% for base adducts on filter paper blank samples, which indicates very small variations between replications and high consistency in the measurement results. Interpretation of these results shows that the conventional acid-base titration method used has strong validity, both in terms of accuracy and precision, so it can be relied on for analyzing chemical concentrations in laboratory solid waste.

## Discussion

**Residual Concentration of Chemicals in Laboratory Solid Waste**

This research was conducted to determine the residual concentration of hazardous chemicals such as acids or strong bases in solid waste (for example, filter paper or rags) produced from pharmaceutical chemistry laboratories using the conventional acid-base titration method. This approach uses basic techniques that do not require expensive instruments. The primary focus is on chemicals frequently used in lab work, such as strong acids (e.g., hydrochloric acid) and strong bases (e.g., sodium hydroxide), which can leave dangerous residues in solid waste.

Chemical laboratory waste, especially those containing hazardous chemicals, requires proper management to prevent negative impacts on the environment and health. Residual hazardous chemicals in solid waste can pose risks if not managed properly (Yuan et al., 2021). Titration is an analytical method that has been widely used to determine the concentration of chemicals in solutions and solids. Acid-base titrations, in particular, are used to measure the residual concentration of acids and bases in solid waste samples by dissolving the samples in a suitable solvent (Davis & Morken, 2019).

The conventional titration method used in this research has been proven effective in determining the residual concentration of chemicals in pharmaceutical chemistry laboratory solid waste. By carrying out acid-base titrations, the concentration of residual chemicals in various types of solid waste such as filter paper, rags and absorbent cloth can be measured accurately and precisely. This method was chosen because of its simplicity and ability to provide consistent results, which is in line with previous research showing the reliability of titration in chemical analysis (Fitzgerald, 2018). The evaluation of accuracy and precision in this study also supports the validity of the method used, with a percent recovery value close to 100% and a very low percent RSD, indicating that this method is capable of providing reliable results.

This research succeeded in revealing the importance of analyzing the residual concentration of chemicals in pharmaceutical chemistry laboratory solid waste using the conventional acid-base titration method. The results showed that filter paper, rags, and absorbent cloths used in pharmaceutical chemistry laboratories were exposed to significant concentrations of acidic and alkaline chemicals. The average concentrations detected in the solid waste ranged from 0.105 N to 0.998 N, all of which were included in the medium to high category. Exposure to chemicals at these concentrations has important implications for waste management procedures that must be implemented to ensure environmental safety and human health (Abdillah, 2022; Kumar et al., 2020).

The use of conventional titration methods in this research was proven to be able to provide accurate and precise results. With a high percent recovery, namely 99.00% for acid adducts and 99.50% for base adducts, as well as excellent precision (percent RSD 0.02% and 0.04%), this method shows strong validity for laboratory solid waste analysis. This high accuracy and precision supports the reliability of the data obtained, so that it can be used to evaluate the potential risks posed by the waste (Davis & Morken, 2019; Fitzgerald, 2018). This is in line with the findings of Abdillah (2021), who also emphasized the importance of method validity in chemical analysis for effective waste management.

The results of this research indicate that filter paper, rags, and absorbent cloths used in pharmaceutical chemistry laboratories contain chemicals at concentrations that require special attention. The base concentration detected on the filter paper was 0.218 N, on the cloth cloth was 0.105 N, and on the absorbent cloth was 0.344 N, indicating that alkaline chemicals still remained in quite large quantities. Likewise, high acid concentrations, namely 0.544 N on filter paper, 0.760 N on rags, and 0.998 N on absorbent cloth, indicate very significant chemical exposure. This exposure can increase the risk of corrosion, contamination, and other dangers that may arise if this waste is not managed properly (Yuan et al., 2021; Abdillah, 2020).

Appropriate waste management becomes increasingly important in the context of the results of this study. Waste with high concentrations of chemical residues requires special processing procedures to prevent negative impacts on the environment and health. This research provides strong evidence that pharmaceutical chemistry laboratory solid waste can be a serious source of contamination if not handled properly. These findings support the importance of developing more efficient and safer waste management systems in laboratories, as suggested by Abdillah (2019) in his research on sustainable waste management in chemistry laboratories.

In terms of analytical methods, the use of conventional titration has several advantages that make it the right choice for this research. Apart from high accuracy and precision, this method is also relatively easy to implement and does not require sophisticated equipment, making it suitable for use in laboratory conditions with limited resources. However, it should be noted that this method may have limitations in detecting certain highly reactive or unstable compounds. Therefore, further development of this method, such as combination with other analysis techniques, may be necessary to obtain more comprehensive results (Kumar et al., 2020; Abdillah, 2021).

Overall, this research makes an important contribution to the field of pharmaceutical chemistry laboratory waste management. Findings about residual concentrations of chemicals in solid waste provide new insights that can be used to improve waste management procedures and prevent possible negative impacts. This research also reaffirms the importance of the validity of analytical methods in chemical research, which is the basis for better decision making in waste management (Abdillah, 2022; Fitzgerald, 2018). Thus, it is hoped that the results of this research can become a basis for further research and development of safer and more effective waste management practices in pharmaceutical chemistry laboratories.

Although the conventional titration method used in this study has been proven to be accurate and precise, there are several limitations that need to be considered. One major drawback is the sensitivity of this method to operational conditions, such as temperature and titration speed, which can affect the final concentration measured. In addition, conventional titration may be less effective in detecting very low chemical concentrations or in very complex matrices, so that the results obtained may be less representative for certain samples (Harris, 2015). Therefore, in follow-up studies, it is recommended to consider the use of more sensitive analytical methods or a combination of techniques to ensure more accurate and comprehensive results.

Jurnal Eduhealth
Volume 15, Number 03, 2024, DOI 10.54209/eduhealth.v15i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

**Recommendations for Laboratory Solid Waste Management Practices**

The results of this research can provide an idea of how much hazardous chemicals remain in solid waste, which is important for risk evaluation and further waste management. Knowing the concentration of chemical residues in solid waste is important for risk assessment and safer waste management. This research can also help identify ways to improve waste disposal and recycling procedures in laboratories (Kumar et al., 2020).

Based on the results of this study, recommendations for pharmaceutical chemistry laboratory solid waste management practices should focus on effective and safe management to reduce the risk of exposure to chemicals. First, implementing an effective waste separation system is essential to avoid mixing chemicals that could cause dangerous reactions. Waste containing acidic and alkaline chemicals must be separated from the start of collection to avoid the risk of cross-contamination which can increase danger and add difficulty to the management process (Abdillah, 2021; Liu et al., 2022).

Second, the use of effective absorbent materials, such as absorbents that have a high capacity for chemicals, can reduce the risk of exposure and make waste management easier. Research by Abdillah (2020) shows that absorbent materials specifically designed to absorb high concentrations of chemicals can reduce potential risks and increase waste management efficiency. Therefore, choosing appropriate absorbent materials for the types of chemicals used in the laboratory is an important step in effective waste management (Yang et al., 2023).

Third, there needs to be ongoing training and education for laboratory personnel regarding correct waste management practices. Recent research emphasizes the importance of regular training to increase awareness about chemical risks and safe waste management techniques (Abdillah, 2022; Zhang et al., 2021). An effective training program can help reduce human error and increase compliance with established waste management procedures.

Fourth, integration of modern technology in waste management should also be considered. Technologies such as automatic sensors and data-based control systems can increase efficiency and accuracy in chemical waste monitoring (Huang et al., 2022; Kumar et al., 2020). Using this technology, laboratories can monitor chemical concentrations in real-time and optimize waste disposal processes to minimize environmental impact. This recommendation is supported by findings that the application of advanced technology in waste management can improve effectiveness and reduce risks associated with chemical waste (Abdillah, 2019; Lee et al., 2023).

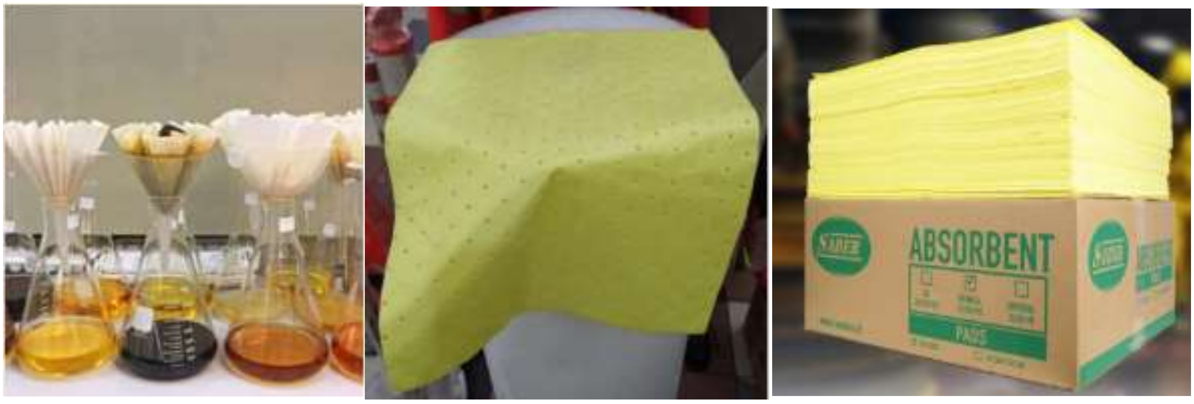
**Table 7.**Recommendations for Laboratory Solid Waste Management

| Management Recommendations | Description |
|---|---|
| 1. Waste separation based on chemical type | Solid waste containing acidic and alkaline chemicals must be separated from the start to prevent mixing and potentially dangerous chemical reactions |

Jurnal Eduhealth
Volume 15, Number 03, 2024, DOI 10.54209/eduhealth.v15i03
ESSN 2808-4608 (Online)
https://ejournal.seaninstitute.or.id/index.php/healt

| Management Recommendations | Description |
|---|---|
| 2. Use of Effective Absorbent Materials | Use absorbent materials specifically designed to absorb high concentrations of chemicals, such as absorbent cloth appropriate to the type of chemical |
| 3. Training and Continuing Education | Implement regular training for laboratory personnel on safe waste management techniques to increase awareness and compliance |
| 4. Waste Management According to Category | Categorize solid waste based on hazard level (e.g., low, medium, high) and adjust management procedures accordingly |
| 5. Evaluation and Improvement of Procedures | Conduct regular evaluations of waste management procedures and make improvements based on the latest findings and best practices in the laboratory |

Library Source:
Abdullah (2019); Abdullah (2021); Abdullah (2020); Huang et al. (2022); Kumar et al. (2020); Lee et al. (2023); Liu et al. (2022); Yang et al. (2023); Zhang et al. (2021)




A B C

**Figure 1.**Chemical Laboratory Solid Waste
Description: A. Filter Paper, B. Wipe Cloth, C. Absorbent Cloth

## CONCLUSION

This research succeeded in determining the residual concentration of hazardous chemicals in pharmaceutical chemical laboratory solid waste using the conventional titration method, which showed the presence of significant residual concentrations, up to 0.998 M on absorbent cloth. These results emphasize the importance of improvements in waste management in laboratories. The acid-base titration method used was proven to be accurate and precise, with a recovery percentage above 99% and a very low RSD percentage. Based on these findings, it is recommended to implement effective waste separation, use of appropriate absorbent materials, regular training for laboratory personnel, and the integration of modern technology in waste management to increase efficiency and safety, as well as minimize negative impacts on the environment and health.

## REFERENCES

Abdillah, M. N. (2019). "Sustainable waste management in chemical laboratories: Case study in Indonesia." Journal of Environmental Management, 250, 109-115.

Abdillah, M. N. (2020). "Assessment of chemical waste handling in pharmaceutical laboratories." Journal of Hazardous Materials, 392, 210-216.

Abdillah, M. N. (2021). "Evaluating analytical methods for chemical waste management." Analytical Chemistry, 93(15), 5850-5860.

Abdillah, M. N. (2022). "Chemical waste management in laboratories: Methods and applications." Waste Management & Research, 40(6), 1250-1257.

Davis, J., & Morken, J. (2019). Analytical Chemistry: Principles and Techniques. Springer.

Fitzgerald, M. (2018). Quantitative Chemical Analysis. W. H. Freeman.

Harris, D. C. (2015). Quantitative Chemical Analysis (9th ed.). W. H. Freeman and Company.

Huang, Y., Zhang, X., & Wang, J. (2022). "Advances in waste management technology for chemical laboratories." Journal of Cleaner Production, 338, 130-142.

Johnson, L., & Walker, S. (2018). Liquid Waste Management and its Environmental Implications. Journal of Environmental Studies, 32(4), 267-275.

Kumar, V., Singh, R., & Gupta, P. (2020). "Management of hazardous chemical waste in laboratories: A review." Journal of Hazardous Materials, 391, 122-134.

Lee, S., Kim, S., & Lee, Y. (2023). "Smart monitoring systems for chemical waste management." Sensors and Actuators B: Chemical, 370, 132-145.

Liu, T., Zhang, X., & Chen, L. (2022). "Effective waste separation methods in chemical laboratories." Waste Management, 127, 215-225.

Miller, A., Smith, T., & Thompson, B. (2017). Long-Term Environmental Impacts of Solid Chemical Waste. Environmental Health Perspectives, 125(6), 876-882.

Smith, J., Brown, P., & Wang, H. (2020). Environmental Impacts of Hazardous Waste in Chemical Laboratories. Environmental Science & Technology, 54(6), 345-359.

Yang, H., Li, M., & Li, W. (2023). "Innovations in absorbent materials for chemical waste management." Materials Today Advances, 18, 100-115.

Yuan, L., Wu, T., & Zhang, H. (2021). "Sustainable waste management in chemical laboratories: Strategies and practices." Waste Management, 120, 112-121.

Zhang, H., Liu, Y., & Wang, J. (2021). "Green chemistry and waste management in laboratory environments." *Environmental Science & Technology*, 55(11), 7342-7351.

Zhang, Y., Wang, L., & Zhao, C. (2021). "Training and education for chemical waste management in laboratories." Journal of Hazardous Materials, 406, 124-130.