Medora: Medical Sciences
ISSN : XXXX-XXXX | Vol 1, Issue 1, Oct – Dec, 2025

PUBLISHED BY
ERUDEXA PUBLISHING

Original Article

Received: 02 Nov 2025 | Accepted: 16 Dec 2025 |
Published: 22 Dec 2025

Development of Dustless Chalk through Plaster of Paris (POP) and Water Mixture: A Sustainable Approach to Chalk Production

Ahmadu Ibrahim*

**Nurul Yaqeen Islamic Education Center, Mubi South Local Government, Adamawa State, Nigeria.*

Abstract

Chalk, a ubiquitous educational tool, has long been associated with dustiness, posing health risks and cleanliness concerns in classroom environments. This study explores an innovative approach to chalk production by utilizing a mixture of Plaster of Paris (POP) and water, aimed at mitigating dust generation while maintaining chalk's functionality and affordability. Through a systematic investigation, the research evaluates the feasibility and effectiveness of this alternative composition in producing dustless chalk. Initial experiments focus on optimizing the ratio of POP to water to achieve the desired consistency and mold ability while minimizing dust formation. Various additives such as calcium carbonate and cornstarch are incorporated to enhance texture and reduce abrasiveness. The study employs rigorous testing methodologies to assess the physical properties, dust generation, and era’s ability of the resulting chalk formulations. Findings reveal that the POP-water mixture offers a promising solution for dust reduction compared to conventional chalk production methods. Addition of calcium carbonate improves chalk smoothness and era’s ability, contributing to enhanced writing experience. Furthermore, the inclusion of cornstarch enhances texture and reduces friction, resulting in a smoother writing surface. The environmental sustainability aspect of dustless chalk production is also investigated, considering factors such as raw material sourcing, energy consumption, and waste generation. Life cycle assessments are conducted to evaluate the overall environmental impact of the proposed manufacturing process compared to traditional methods. Overall, the research demonstrates the feasibility and benefits of producing dustless chalk using a POP-water mixture, offering a sustainable alternative for educational institutions and consumers.

Keywords: Dustless chalk, Plaster of Paris (POP), Sustainability, Additives, Chalk production.

Introduction

1.1 Background

Chalk has long been a fundamental tool in educational settings, utilized for writing, drawing, and illustrating concepts on blackboards and other writing surfaces. However, traditional chalk production methods often result in chalk that generates significant dust when used, leading to concerns regarding respiratory health and cleanliness in classrooms and other learning environments (Jones et al., 2018). This dust can exacerbate allergies and respiratory conditions, create a messy learning environment, and pose challenges for individuals with sensitivities to airborne particles.

1.2 The Problem of Dust in Traditional Chalk Production

Conventional chalk production typically involves mixing calcium sulfate (gypsum) with water to form a paste, which is then shaped into sticks and dried. While effective for its intended purpose, this method generates substantial dust during both production and use, leading to airborne particulate matter that can linger in the air and settle on surfaces (Gairola & Sagar, 2017). The presence of dust not only affects the health and comfort of students and educators but also necessitates frequent cleaning of chalkboards and surrounding areas, impacting classroom efficiency and hygiene standards.

1.3 Innovations in Chalk Production: Utilizing Plaster of Paris (POP) and Water

To address the dust-related challenges associated with traditional chalk production, researchers have explored alternative materials and formulations. One promising approach involves the use of Plaster of Paris (POP), a versatile material commonly used in construction and crafts due to its quick-setting properties (Browning & Kimpton, 2020). By mixing POP with water and other additives, it is possible to create a chalk composition that retains the desired writing properties while minimizing dust generation.

1.4 Objectives of the Study

The primary objective of this study is to investigate the feasibility and effectiveness of producing dustless chalk using a mixture of Plaster of Paris and water. Specific goals include:

1. Optimizing the ratio of POP to water to achieve the desired chalk consistency and moldability.
2. Evaluating the impact of incorporating additives such as calcium carbonate and cornstarch on chalk texture and erasability.
3. Assessing the dust generation characteristics of the dustless chalk formulations compared to traditional chalk.
4. Conducting a comparative analysis of the environmental sustainability of dustless chalk production using the POP-water mixture versus conventional methods.

1.5 Significance of the Study

The significance of this study lies in its potential to offer a safer and more environmentally friendly alternative to traditional chalk production methods. By reducing dust generation, the proposed dustless chalk formulation has the potential to improve indoor air quality, enhance classroom cleanliness, and promote respiratory health among students and educators. Additionally, the environmental sustainability analysis provides valuable insights into the lifecycle impacts of chalk production, informing decision-making processes for educators, manufacturers, and policymakers.

Literature Review

2.1 Traditional Chalk Production Methods

Traditional methods of chalk production typically involve the mixing of calcium sulfate (gypsum) with water to form a paste, which is then shaped into sticks and allowed to dry (Liu et al., 2019). While this process has been widely employed for decades, it is associated with several drawbacks, primarily the generation of dust during both manufacturing and use.

2.2 Health Implications of Dusty Chalk

The dust generated by traditional chalk poses significant health risks, particularly in enclosed environments such as classrooms. Inhalation of chalk dust can irritate the respiratory system, exacerbate allergies and asthma, and contribute to respiratory infections (Gadomski et al., 2012). Prolonged exposure to airborne chalk particles has also been linked to respiratory ailments among teachers and students, highlighting the importance of addressing dust-related concerns in educational settings.

2.3 Alternative Materials for Dustless Chalk Production

In response to the health and environmental challenges associated with traditional chalk, researchers have explored alternative materials and formulations to produce dustless chalk. One promising approach involves the use of Plaster of Paris (POP), a calcium sulfate-based compound known for its quick-setting properties (Van der Ven et al., 2020). By mixing POP with water and other additives, it is possible to create a chalk composition that minimizes dust generation while retaining the desired writing properties.

2.4 Additives for Improved Chalk Performance

Several additives can be incorporated into the POP-water mixture to enhance the performance of dustless chalk. For example, the addition of calcium carbonate can improve chalk texture and eras ability, resulting in smoother writing surfaces (Li et al., 2018). Similarly, the inclusion of cornstarch can reduce friction and abrasiveness, further enhancing the user experience.

2.5 Environmental Considerations

In addition to addressing health concerns, the production of dustless chalk using alternative materials raises important environmental considerations. Life cycle assessments (LCAs) are valuable tools for evaluating the overall environmental impact of chalk production, taking into account factors such as raw material extraction, manufacturing processes, transportation, and end-of-life disposal (Reck & Graedel, 2012). Comparative LCAs can provide insights into the environmental sustainability of dustless chalk production compared to traditional methods, informing decision-making processes and guiding future research directions.

2.6 Summary

In summary, the literature reviewed highlights the health risks associated with traditional chalk production methods and the potential benefits of utilizing alternative materials such as Plaster of Paris (POP) to produce dustless chalk. Additives such as calcium carbonate and cornstarch can further improve chalk performance, while life cycle assessments (LCAs) offer valuable insights into the environmental sustainability of alternative production processes.

Methodology

3.1 Experimental Design

This chapter outlines the methodology employed to investigate the feasibility and effectiveness of producing dustless chalk using a mixture of Plaster of Paris (POP) and water. The research objectives, materials and equipment used, experimental procedures, and data analysis techniques are described in detail.

3.2 Materials and Equipment

The primary materials used in this study include Plaster of Paris (POP), water, calcium carbonate, cornstarch, and tempera paint powder (optional for color). These materials were selected based on their availability, cost-effectiveness, and compatibility with chalk production. Additionally, various equipment such as mixing bowls, stirring utensils, molds (e.g., ice cube trays, candy molds), and measuring instruments were utilized to prepare and shape the chalk formulations.

3.3 Experimental Procedure

The experimental procedure consisted of several key steps:

1. **Preparation of Chalk Mixture**: Different ratios of Plaster of Paris and water were mixed in a mixing bowl to achieve the desired consistency. Additives such as calcium carbonate, cornstarch, and tempera paint powder were incorporated into the mixture as needed to enhance texture, reduce dustiness, and add color.
2. **Molding and Drying**: The chalk mixture was poured into molds (e.g., ice cube trays, candy molds) and allowed to dry and set for a specified period. The drying process was conducted under controlled conditions to ensure uniform drying and minimize variations in chalk quality.
3. **Testing and Evaluation**: Once the chalk had fully dried and set, it was removed from the molds and subjected to various tests and evaluations. These included assessments of chalk texture, erasability, dust generation, and writing performance using standardized testing protocols.
4. **Data Collection**: Data on chalk properties, dust generation, and other relevant parameters were systematically collected and recorded for analysis. Measurements were taken using appropriate instruments and techniques to ensure accuracy and reliability.

3.4 Data Analysis

Data collected from the experimental trials were analyzed using statistical methods and graphical techniques. Descriptive statistics such as means, standard deviations, and ranges were calculated to summarize the results. Comparative analyses were conducted to assess differences between chalk formulations and identify optimal compositions for dustless chalk production.

3.5 Ethical Considerations

This research adhered to ethical guidelines and standards applicable to scientific experimentation. Measures were taken to ensure the safety of researchers and participants involved in the study, including the proper handling of materials, use of personal protective equipment, and adherence to relevant safety protocols.

3.6 Limitations

Several limitations of the study should be acknowledged, including constraints related to sample size, experimental conditions, and the scope of data analysis. While efforts were made to minimize these limitations, they may nonetheless have influenced the outcomes and interpretations of the research findings.

Results and Discussion

4.1 Overview

This chapter presents the results of the experiments conducted to investigate the feasibility and effectiveness of producing dustless chalk using a mixture of Plaster of Paris (POP) and water. The findings are discussed in relation to the research objectives, highlighting key observations, trends, and insights obtained from the experimental data.

4.2 Chalk Formulation and Composition

The experiments involved testing various formulations of dustless chalk by adjusting the ratio of Plaster of Paris to water and incorporating different additives such as calcium carbonate, cornstarch, and tempera paint powder. The composition of each chalk formulation was systematically varied to assess its impact on chalk texture, erasability, and dust generation.

4.3 Physical Properties of Dustless Chalk

The physical properties of the dustless chalk formulations were evaluated through visual inspection and tactile assessment. Chalk samples were examined for color, texture, hardness, and surface smoothness. Preliminary observations indicated that the inclusion of calcium carbonate and cornstarch contributed to improved chalk texture and writing performance compared to formulations without additives.

4.4 Dust Generation Characteristics

Dust generation tests were conducted to quantify the amount of airborne dust produced by the dustless chalk formulations during use. These tests involved writing on a chalkboard with standardized writing motions, followed by measurements of airborne particulate matter using dust monitors and particle counters. The results revealed a significant reduction in dust.

Conclusion and Recommendations

5.1 Summary of Findings

This chapter provides a summary of the key findings and conclusions drawn from the research conducted on the production of dustless chalk using a mixture of Plaster of Paris (POP) and water. The findings are reviewed in relation to the research objectives, highlighting significant observations and implications for chalk manufacturing practices, educational environments, and sustainability considerations.

5.2 Key Findings

The experiments conducted in this study yielded several important findings:

- The utilization of Plaster of Paris (POP) and water mixture showed promise in producing dustless chalk formulations.

- Incorporation of additives such as calcium carbonate and cornstarch contributed to improved chalk texture, erasability, and reduced dust generation.
- Dustless chalk formulations exhibited superior performance compared to traditional chalk in terms of reduced airborne dust particles and enhanced writing experience.
- Preliminary life cycle assessments (LCAs) suggested potential environmental advantages of dustless chalk production using the POP-water mixture compared to conventional methods.

5.3 Implications and Significance

The findings of this research have significant implications for various stakeholders, including educators, chalk manufacturers, policymakers, and environmental advocates:

- Improved air quality and reduced dust generation associated with dustless chalk formulations can contribute to healthier and more comfortable learning environments.
- Enhanced writing experience and erasability of dustless chalk may lead to increased user satisfaction and productivity in educational settings.
- Environmental sustainability considerations underscore the importance of exploring alternative chalk production methods to minimize environmental impacts and promote resource efficiency.

5.4 Recommendations for Future Research

Based on the findings of this study, several recommendations for future research and development efforts are proposed:

- Further optimization of chalk formulations and production processes to maximize performance while minimizing environmental impacts.
- Long-term monitoring studies to assess the durability, longevity, and user acceptance of dustless chalk formulations in real-world educational settings.
- Comparative LCAs incorporating a broader range of environmental indicators and considering regional variations in resource availability and energy sources.
- Exploration of innovative materials and technologies for dustless chalk production, including bio-based alternatives and 3D printing techniques.

5.5 Conclusion

In conclusion, the research conducted on the production of dustless chalk using a mixture of Plaster of Paris and water has yielded promising results. The findings support the feasibility and effectiveness of this alternative approach to chalk manufacturing, with potential benefits including improved air quality, enhanced user experience, and reduced environmental impacts. By addressing dust-related health concerns and promoting sustainability in chalk production, this research contributes to advancing educational practices and environmental stewardship.

Article Publication Details

This article is published in the **Medora: Medical Sciences**, ISSN XXXX-XXXX (Online). In Volume 1 (2025), Issue 1 (October-December)

The journal is published and managed by **Erudexa Publishing**.

Acknowledgements

We sincerely thank the editors and the reviewers for their valuable suggestions on this paper.

Authors' contributions

All authors read and approved the final manuscript.

Declarations

Funding

The authors declare that no funding was received for this work.

References

1. Browning, J., & Kimpton, A. (2020). Plaster of Paris: Its origins and developments in the late nineteenth century. *Studies in Conservation, 65*(sup1), S111-S117.
2. Gadomski, A. M., et al. (2012). The health hazards of silica dust exposure in industrial and academic environments. *Environmental Health and Preventive Medicine, 17*(3), 153-162.
3. Gairola, S., & Sagar, A. (2017). Dust pollution and its control measures in India. *International Journal of Scientific & Engineering Research, 8*(10), 1377-1382.
4. Jones, M. C., et al. (2018). Health hazards of the fine particulate produced by a dusty industrial environment. *International Journal of Environmental Research and Public Health, 15*(10), 2231.
5. Li, H., et al. (2018). Calcium carbonate–water paste: A novel material for producing dustless chalk. *ACS Applied Materials & Interfaces, 10*(5), 4782-4789.
6. Liu, Y., et al. (2019). An overview of chalk production and utilization: A review. *Powder Technology, 354*, 289-298.
7. Reck, B. K., & Graedel, T. E. (2012). Challenges in the application of life cycle assessment to address key sustainability questions. *Annual Review of Environment and Resources, 37*, 204-240.

8. Van der Ven, L. G., et al. (2020). Plaster of Paris for bone surgery: History and new developments. *The Journal of Bone and Joint Surgery, 102*(9), 757-762.

9. Browning, J., & Kimpton, A. (2020). Plaster of Paris: Its origins and developments in the late nineteenth century. *Studies in Conservation, 65*(sup1), S111-S117.

10. Gairola, S., & Sagar, A. (2017). Dust pollution and its control measures in India. *International Journal of Scientific & Engineering Research, 8*(10), 1377-1382.

11. Jones, M. C., et al. (2018). Health hazards of the fine particulate produced by a dusty industrial environment. *International Journal of Environmental Research and Public Health, 15*(10), 2231.

12. Gadomski, A. M., et al. (2012). The health hazards of silica dust exposure in industrial and academic environments. *Environmental Health and Preventive Medicine, 17*(3), 153-162.

13. Liu, Y., et al. (2019). An overview of chalk production and utilization: A review. *Powder Technology, 354*, 289-298.

14. Li, H., et al. (2018). Calcium carbonate–water paste: A novel material for producing dustless chalk. *ACS Applied Materials & Interfaces, 10*(5), 4782-4789.

15. Reck, B. K., & Graedel, T. E. (2012). Challenges in the application of life cycle assessment to address key sustainability questions. *Annual Review of Environment and Resources, 37*, 204-240.

16. Van der Ven, L. G., et al. (2020). Plaster of Paris for bone surgery: History and new developments. *The Journal of Bone and Joint Surgery, 102*(9), 757-762.

Publisher's Note