Synthesis of Oxalic Acid from Sugar Crystals for Enhanced Detergent Quality

Internship Report

Submitted for the partial fulfilment of the degree of

Bachelor of Technology

In

CHEMICAL ENGINEERING

Submitted By

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UNDER THE SUPERVISION AND GUIDANCE OF

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ABSTRACT

This paper aims to yield oxalic acid from sucrose with the assistance of nitric acid and explore its application in enhancing detergent quality. Oxalic acid, a dicarboxylic acid, was chosen due to its potential as a chelating agent and its ability to improve detergent performance. The production process involved a carefully controlled reaction between sugar crystals (sucrose) and nitric acid, followed by a series of purification steps to obtain high-quality oxalic acid suitable for detergent formulations. Analytical techniques were employed to verify the purity and quality of the produced oxalic acid. The purified oxalic acid was then systematically incorporated into various detergent formulations to assess its effectiveness in improving cleaning efficiency, stain removal, and overall performance. Comparative tests were conducted to evaluate the enhanced detergents against standard formulations. The results demonstrated the feasibility of utilizing oxalic acid derived from sugar crystals to enhance detergent quality, highlighting its potential applications in the detergent industry and paving the way for further innovations in detergent formulation and performance optimization.

Keywords - Oxalic acid, Detergent, Sugar, Nitric Acid.

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ACKNOWLEDGEMENT

The Major project has proved to be pivotal to my career. I am thankful to my institute, Madhav Institute of Technology and Science to allow me to continue my disciplinary/interdisciplinary project as a curriculum requirement, under the provisions of the Flexible Curriculum Scheme (based on the AICTE Model Curriculum 2018), approved by the Academic Council of the institute. I extend my gratitude to the Director of the institute, **Dr. R. K. Pandit** and Dean Academics, **Dr. Manjaree Pandit** for this.

I would sincerely like to thank my department, Department of Chemical Engineering, for allowing me to explore this project.

I am sincerely thankful to my faculty mentors. I am grateful to the guidance of **Dr. Sourabh Singh Raghuwanshi**, Assistant Professor, Department of Chemical Engineering, for her continued support and guidance throughout the project. I am also very thankful to the faculty and staff of the department.

Kartik Thakre

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NOMENCLATURE

OA - OXALIC ACID

NA - NITRIC ACID

DQ - DETERGENT QUALITY

DA - DICARBOXYLIC ACID

CA - CHELATING AGENT

DP - DETERGENT PERFORMANCE

SC - SUGAR CRYSTALS

AT - ANALYTICAL TECHNIQUES

CE - CLEANING EFFICIENCY

ST - STAIN REMOVAL

SF - STANDARD FORMULATIONS

ED - ENHANCED DETERGENTS

DI - DETERGENT INDUSTRY

PO - PERFORMANCE OPTIMIZATION

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CHAPTER 1: INTRODUCTION

Detergents, often taken for granted in our daily lives, are the unsung heroes of cleanliness and hygiene. From the clothes we wear to the surfaces we touch; detergents play a pivotal role in maintaining a sanitary environment and preserving our health. In this report, we explore the multifaceted importance of detergents across various sectors of society. By delving into their role in cleaning, disinfection, fabric care, environmental sustainability, industrial applications, personal hygiene, and public health, we uncover the indispensable nature of detergents in modern life. Through this examination, we aim to shed light on the significance of detergents and the critical need for their continued innovation and utilization in maintaining cleanliness, hygiene, and well-being.

Detergents play a crucial role in our daily lives, from maintaining cleanliness to ensuring hygiene. This report delves into the significance of detergents in various aspects of our society.

Maintaining Cleanliness: Detergents are essential for cleaning surfaces, fabrics, and utensils. They help remove dirt, grease, and stains effectively, ensuring a clean and hygienic environment.

Ensuring Hygiene: In addition to cleaning, detergents possess disinfectant properties that help eliminate harmful bacteria and germs. This is particularly important in settings such as hospitals, restaurants, and households where hygiene is paramount.

Preserving Fabric Quality: Specialized detergents designed for fabrics help preserve their quality and longevity. By removing dirt and stains gently, these detergents prevent fabric damage and maintain their original appearance and texture.

Environmental Sustainability: Modern detergents are formulated to be eco-friendly, reducing their environmental impact. Biodegradable ingredients and phosphate-free formulations contribute to minimizing pollution and protecting natural ecosystems.

Industrial and Commercial Applications: Detergents are widely used in industrial and commercial settings for various purposes, including cleaning machinery, equipment, and vehicles. They play a vital role in maintaining operational efficiency and safety standards.

Enhancing Personal Care: Personal care products such as shampoos, soaps, and body washes contain detergents that cleanse the skin and hair effectively. These detergents remove dirt, oil, and impurities without causing irritation, contributing to overall personal hygiene.

Supporting Public Health: In public health initiatives, detergents are instrumental in sanitation practices, helping prevent the spread of diseases and infections. Proper cleaning and disinfection protocols, often utilizing detergents, are essential in healthcare facilities, schools, and public spaces.

Oxalic acid, a naturally occurring compound found in various plants and vegetables, has emerged as a potent cleaning agent with a wide array of applications. In this section of the report, we delve into the importance of oxalic acid as a cleaning agent, examining its effectiveness, versatility, and eco-friendly attributes.

Oxalic acid ($C2H2O4$) is a crucial organic compound extensively utilized in various industrial applications, including the textile, pharmaceutical, and detergent industries. In detergents, oxalic acid acts as a bleaching agent and a potent chelating agent, which enhances the cleaning efficacy by binding with metal ions and preventing them from interfering with the cleaning process. The synthesis of oxalic acid from sugar crystals presents an innovative and cost-effective method that not only leverages a renewable resource but also potentially reduces environmental impact compared to traditional manufacturing processes.

Superior Stain Removal: Oxalic acid exhibits exceptional stain removal properties, making it invaluable in cleaning applications. Its acidic nature allows it to dissolve and lift stubborn stains caused by rust, watermarks, mineral deposits, and organic matter with remarkable efficiency. Whether used on surfaces, fabrics, or kitchenware, oxalic acid proves to be a powerful ally in restoring cleanliness and appearance.

Effective Rust Removal: One of the notable strengths of oxalic acid lies in its ability to effectively remove rust and corrosion from various surfaces. By forming soluble complexes with iron oxides, oxalic acid facilitates the breakdown and dissolution of rust, leaving surfaces clean and corrosion-free. This makes it an indispensable tool in industries such as automotive, manufacturing, and metalworking.

Versatile Cleaning Applications: The versatility of oxalic acid extends beyond stain and rust removal. It finds applications in cleaning and brightening wood surfaces, removing ink stains, and restoring the luster of metal surfaces. Its multifaceted nature makes it a preferred choice for addressing a wide range of cleaning challenges in both domestic and industrial settings.

Eco-Friendly Attributes: Despite its formidable cleaning power, oxalic acid is considered environmentally friendly when used responsibly. As a naturally occurring compound, it undergoes biodegradation and poses minimal risk to ecosystems when properly disposed of. Moreover, its effectiveness at lower concentrations reduces the need for harsh chemicals, contributing to sustainable cleaning practices.

Safety Considerations: While oxalic acid offers significant cleaning benefits, it is essential to handle it with care due to its acidic nature. Protective equipment such as gloves and goggles should be worn when working with oxalic acid to prevent skin and eye irritation. Additionally, proper ventilation is recommended to minimize exposure to fumes.

The detergent industry is continuously seeking ways to improve product quality and environmental sustainability. Conventional methods of producing oxalic acid often involve harsh chemicals and energy-intensive processes. However, utilizing sugar crystals as a feedstock for oxalic acid synthesis offers a promising alternative. Sugar, primarily sucrose, is a readily available and renewable resource that can be converted into oxalic acid through oxidation reactions. This method aligns with the growing emphasis on green chemistry and sustainable industrial practices.

The reaction involves the catalytic oxidation of sucrose, typically using nitric acid and a catalyst such as vanadium pentoxide ($V2O5$). The overall chemical reaction can be represented as follows:

$C12H22O11 + HNO3 \rightarrow C2H2O4 + H2O$ + by-products

The synthesis of oxalic acid from sugar crystals, specifically sucrose, presents an innovative approach to improving the quality of detergents. Oxalic acid, a potent dicarboxylic acid, is known for its excellent chelating properties, which make it highly effective in binding and removing metal ions. These properties are particularly beneficial in the formulation of detergents, where metal ions can interfere with cleaning efficacy and cause the deposition of residues on fabrics and surfaces.

Traditional methods of producing oxalic acid often involve complex processes and the use of costly raw materials. In contrast, converting sucrose into oxalic acid using nitric acid offers a more straightforward and cost-effective alternative. This method not only utilizes a common and renewable resource but also aligns with sustainable chemical practices by providing a greener synthesis route.

This report aims to explore the feasibility of synthesizing oxalic acid from sucrose, detailing the chemical reaction mechanisms, optimizing reaction conditions, and refining purification processes to achieve high-purity oxalic acid. Furthermore, the study examines the application of this synthesized oxalic acid in detergent formulations, evaluating its impact on cleaning efficiency, stain removal capabilities, and overall performance enhancement.

Incorporating oxalic acid into detergents is expected to enhance their performance, particularly in hard water conditions where metal ion interference is a significant issue. This research highlights the potential for creating more effective and environmentally friendly cleaning products by integrating oxalic acid derived from sugar crystals.

Through this investigation, we aim to demonstrate the practicality and advantages of synthesizing oxalic acid from sucrose, providing valuable insights into its applications in the detergent industry. This work contributes to the advancement of chemical synthesis techniques and promotes the development of superior detergents that meet contemporary consumer and environmental standards.

There are, essentially, six methods for manufacturing oxalic acid, and the procedure depends on the specified raw material. It can be derived from vibrant accessories such as ethylene, ethylene glycol, propylene, wood pulp, syrup, sugarcane, sweeteners, grains, industrial residues, formic acid, carbonates, and bicarbonates, among others."

These styles are classified in six groups

- **Emulsion of sawdust with acidulous soda pop**
- **Oxidation reaction of olefines and glycols**
- **Radiation processing of carbonate results and molasses**
- **Turmoil of carbohydrates**
- **Oxidation reaction of carbohydrates by nitric acid**

In this study, the product of oxalic acid was realized from dishes, with nitric acid. The end of the present study was to probe and try to enhance the soap quality. Detergent quality plays a vital part in everyday life, affecting cleanliness, hygiene, and environmental impact.

Artificial detergents hold a significant position in contemporary times, especially as society continually seeks rapid, efficient, and economically viable cleansing agents. These synthetic cleansers emerged as a commonplace industry only after the Second World War. Their evolution is closely intertwined with the petrochemical industry, which provides the foundation for their raw materials. When dissolved in water, these cleansers exhibit superior cleansing properties, facilitating the easy removal of dirt, dust, and grease.

Figure 1: From Brands-of-India. BlogSpot

CHAPTER 2: LITERATURE SURVEY

The synthesis of oxalic acid from sugar crystals to enhance detergent quality represents a novel approach in the realm of cleaning agents. In recent years, there has been growing interest in exploring alternative sources and methods for producing oxalic acid, driven by the need for sustainable and eco-friendly solutions in the detergent industry. This section of the literature review examines key studies and research findings relevant to this innovative approach, shedding light on its potential benefits and implications.

Under optimal conditions as delineated in this study, it becomes feasible to combine sawdust with alkali to achieve significant yields of acetic acid, oxalic acid, methanol, and formic acid. These yields may reach levels sufficient to ensure the profitable operation of such a process. Enhanced yields can be achieved by fusing the mixture in thin layers. However, conducting the reaction in the conventional manner and introducing air over the mixture yielded results that closely approached those obtained from thin-layer mixtures. By conducting experiments with various types of wood, it has been demonstrated that there exists a proportional relationship between the yields obtained and the quantity of cellulose present in the wood. The observation that the yield in each case slightly exceeded that obtained from pure cellulose suggests that the lignin in the wood also contributes to the reaction.[1]

This finding underscores the potential of using lignocellulosic biomass as a feedstock for producing valuable chemicals, aligning with the principles of green chemistry and sustainability. The process not only utilizes the cellulose content but also leverages the lignin fraction, thus improving overall efficiency and material utilization. The study highlights the importance of optimizing reaction conditions to maximize yields and profitability, paving the way for scalable industrial applications. Future research could focus on refining these conditions further and exploring the mechanistic aspects of lignin's contribution to the reaction, potentially leading to more efficient and sustainable biomass conversion processes. Additionally, investigating the environmental impacts and economic feasibility of scaling up this process could provide valuable insights into its industrial viability, contributing to the development of sustainable chemical production methods.

Microbial production of organic acids has emerged as a promising biotechnological approach for liberating phosphorus (P) from less soluble rock phosphates (RPs). This study investigates the efficacy of naturally occurring acids, commonly linked with microbial phosphorus solubilization—such as citric, gluconic, itaconic, malic, and oxalic acids—when applied individually at different concentrations to improve the solubilization of diverse grades of reactive phosphates. The solubilization of P by organic acids was compared to sulfuric acid, traditionally used in RP solubilization for industrial purposes. The type and concentration of acid had a greater impact on solubilized P than the reactivity of the RP.[2]

Overall, organic acids demonstrated varying levels of effectiveness, with oxalic acid being the most potent, followed by citric, malic, itaconic, and gluconic acids. Both sulfuric acid and oxalic acid completely dissolved the P content in all RPs composed of apatite (Ca5(PO4)3(OH, F, Cl)). However, oxalic acid surpassed sulfuric acid in releasing a higher amount of P per millimole of acid applied. On average, each millimole of oxalic acid liberated 21 milligrams of phosphorus, while sulfuric acid dissolved 14 milligrams of phosphorus per millimole. Consequently, microorganisms capable of producing oxalic acid present a promising avenue for enhancing the mobilization of reactive phosphates through a biotechnological approach.

The implications of these findings are significant for sustainable agriculture and the efficient use of phosphorus resources. By leveraging the natural capabilities of microorganisms to produce effective organic acids, it becomes possible to reduce the reliance on chemical solubilizing agents, thereby minimizing environmental impact and promoting eco-friendly agricultural practices. Future research could explore the optimization of microbial fermentation conditions to maximize oxalic acid production and further enhance phosphorus solubilization. Additionally, investigating the genetic and metabolic pathways of microorganisms involved in oxalic acid biosynthesis could lead to the development of engineered strains with improved efficiency and stability. This approach not only aligns with the goals of sustainable agriculture but also contributes to the broader efforts of resource conservation and environmental protection.[3]

This paper employed kinetic and statistically designed trials to identify the optimal reaction conditions for the nitric acid oxidation of red oak sawdust, aiming to produce oxalic acid in a mixed HNO3/H2SO4/V2O5 response medium. The data indicate that the ideal parameters for batchwise oxalic acid production are as follows: a reaction temperature of 75°C, a reaction time of 2 hours, an H_2SO_4 concentration of 50 wt.%, an HNO_3-to-sawdust ratio of 8:1, a V_2O_5 catalyst amount of 0.003%, and an oxygen inflow rate of 21.1 mL/g of sawdust/min. Under these conditions, the conversion of sawdust to oxalic acid reaches 80.2 wt.%, with a nitric acid recovery rate of 3.59 (g of $H_2C_2O_4$ produced/g of HNO_3 unrecovered). Nitric acid losses occur due to its reduction to N_2 and N_2O, while carbon losses result from the formation of CO_2 and CO. An estimation of the raw material conditions for oxalic acid production is provided.

These findings underscore the potential of using red oak sawdust, a common lignocellulosic waste material, as a feedstock for oxalic acid production. The high conversion efficiency and favourable nitric acid recovery rate highlight the process's economic and environmental viability. Furthermore, the detailed analysis of by-products such as N_2, N_2O, CO_2, and CO provides valuable insights into the reaction mechanisms and pathways involved in the oxidation process.[4]

This study contributes to the growing body of research focused on valorizing biomass waste through chemical processes, offering a sustainable alternative to traditional oxalic acid production methods. Future research could explore the scalability of this process and its integration into existing industrial frameworks, potentially reducing reliance on non-renewable resources and minimizing waste. Additionally, the optimization of catalyst concentrations and the investigation of alternative catalysts could further enhance the efficiency and sustainability of the process. By advancing our understanding of biomass conversion technologies, this research supports the development of greener and more sustainable industrial practices.
A new method employing nitric acid oxidation was developed to produce oxalic acid from sugarcane residue, groundnut shells, corn cobs, and rice husks. Favorable yields of oxalic acid (ranging from 42.9% to 51.6% w/w) were achieved from these raw materials under optimal conditions, with sugarcane residue being the preferred feedstock. Additionally, the treatment of waste nitrogen oxides with anhydrous NaOH to obtain a valuable by-product, sodium nitrite, proved to be successful.

This innovative approach not only provides an efficient way to valorize agricultural waste but also aligns with the principles of sustainable and green chemistry. By utilizing readily available and renewable biomass resources, this method reduces the dependence on fossil fuels and minimizes environmental impact. The successful recovery of sodium nitrite as a by-product further enhances the economic viability of the process, presenting an additional revenue stream and reducing overall waste.[5]

Moreover, the study highlights the importance of optimizing reaction conditions to maximize yield and efficiency. Future research could focus on refining these conditions further and exploring the potential for scaling up the process for industrial applications. Investigating the mechanistic pathways and kinetics of the oxidation reaction could provide deeper insights into the process, enabling further optimization and innovation.

This method represents a significant advancement in the field of biomass conversion, demonstrating the potential for integrated biorefinery approaches that convert agricultural residues into high-value chemicals. By addressing both economic and environmental challenges, this research paves the way for more sustainable industrial practices and contributes to the development of a circular economy.

The most effective strategy for producing affordable oxalic acid on a large scale involves the nitric acid oxidation of plant residues, provided that the majority of the nitric acid can be recuperated for subsequent use. Optimal conditions of temperature, catalyst concentration, and reaction duration yield oxalic acid from wood and straw residues at rates reaching up to 85%. However, the loss of nitric acid is minimal only when employing fuming nitric acid. Under these circumstances, the ratio of oxalic acid generated to nitric acid expended stands at 7:1. The nitric acid that is lost undergoes conversion primarily into nitrous oxide, a transformation seemingly linked to the oxidation process of the lignin component within the sawdust.

The nitric acid oxidation method has emerged as a promising approach for the conversion of agricultural residues into valuable chemicals, particularly oxalic acid. Through this method, significant yields of oxalic acid have been achieved from diverse agricultural residues, including sugarcane trash, groundnut shells, corn cobs, and rice husks. The reported yields, ranging from 42.9% to 51.6% by weight, underscore the efficacy of this process in extracting oxalic acid from biomass sources. Among these raw materials, sugarcane trash has demonstrated exceptional performance, emerging as the preferred substrate for oxalic acid production. Additionally, the successful absorption of waste nitrogen oxide gases in aqueous sodium hydroxide to yield sodium nitrite further enhances the economic viability and sustainability of this process.

These findings highlight the potential of the nitric acid oxidation method as a versatile and eco-friendly approach for valorizing agricultural residues into valuable chemical products, thereby contributing to the development of sustainable biomass utilization strategies in the context of circular economy principles. The ability to convert low-value agricultural waste into high-value chemicals presents significant economic benefits, particularly in regions with abundant agricultural by-products. Moreover, the integration of waste gas treatment into the process aligns with environmental sustainability goals, reducing harmful emissions and producing useful by-products.

Future research should focus on optimizing the reaction conditions to further increase yields and reduce processing costs. Investigating the long-term stability and reusability of catalysts, as well as the potential for integrating this method into existing industrial frameworks, could enhance its practical applications. Additionally, life cycle assessments and economic analyses would provide valuable insights into the overall sustainability and feasibility of this approach on a commercial scale. By advancing the understanding and implementation of nitric acid oxidation for biomass conversion, this research contributes to the broader efforts of achieving sustainable and eco-friendly industrial practices

Kinetic and statistically designed experiments were conducted to ascertain the optimal reaction parameters for the nitric acid oxidation of red oak sawdust, aiming to produce oxalic acid within a mixed HNO3/H2SO4/V2O5 reaction milieu. The findings indicate that the most favorable conditions for batch-wise oxalic acid production entail a reaction temperature of 75°C, a reaction duration of 2 hours, a H2SO4 concentration of 50 wt%, an HNO3 to sawdust ratio of 8:1, a V2O5 catalyst concentration of 0.003%, and an oxygen flow rate of 21.1 mL/g of sawdust/min. Under these specified conditions, the conversion of sawdust to oxalic acid reaches 80.2 wt%, with a nitric acid recovery ratio of 3.59 (i.e., g of H2C2O4 produced/g of unrecovered HNO3). Notably, losses of nitric acid are attributed to its reduction to N2 and N2O, while carbon losses result from the formation of CO2 and CO. Furthermore, an estimation of the raw material requirements for oxalic acid production is provided.

This study exemplifies the utilization of experimental design methodologies to optimize reaction conditions for the conversion of red oak sawdust into oxalic acid, shedding light on the intricate interplay between various parameters in the nitric acid oxidation process. The obtained results underscore the importance of fine-tuning reaction parameters to achieve maximum yield and efficiency in biomass conversion processes. Moreover, the identification of by-products and losses aids in understanding the mechanistic aspects of the reaction and paves the way for further process improvements aimed at enhancing sustainability and resource efficiency in chemical production from biomass sources.

Organic acids are crucial compounds with extensive applications across various industries. This review provides a detailed examination of the biological synthesis of oxalic acid, a significant organic acid with numerous industrial uses. Given its vital role in pharmaceuticals, textiles, metal recovery, and the chemical and metallurgical sectors, the global demand for oxalic acid has surged. Consequently, there is an urgent need to develop more environmentally friendly and economically viable alternatives to traditional chemical synthesis methods, leading to an increased focus on microbial fermentation processes.

This review delves into specific strategies for the microbial production of oxalic acid, emphasizing the advantages of using bio-derived substrates to enhance the economic feasibility of the process and support a circular economy, as opposed to conventional chemical synthesis. It provides a thorough analysis of various fermentation methods, the microorganisms involved, and the biochemical pathways of oxalic acid production. Additionally, it highlights critical sustainability challenges and considerations associated with oxalic acid biosynthesis, offering essential insights for future research directions.

Moreover, the review underscores the potential of integrating these microbial processes into existing industrial frameworks, thereby reducing reliance on non-renewable resources and minimizing environmental impact. It also examines recent technological advancements that have improved yield and efficiency in oxalic acid production. By presenting and critically analyzing the latest findings in the literature, this review serves as a comprehensive resource for understanding the biosynthesis of oxalic acid, addressing key research gaps, and paving the way for future innovations in the field. This enhanced understanding can facilitate the development of more sustainable production practices, contributing to the broader goals of green chemistry and sustainable industry practices.

CHAPTER 3: PROBLEM FORMULATION

The problem addressed in this research is the need to enhance detergent quality through the synthesis of oxalic acid from sugar crystals. The objective is to develop a sustainable and cost-effective method for producing oxalic acid, a powerful chelating agent, which can significantly improve the performance of detergents. This involves identifying the optimal conditions and processes for converting sugar crystals into oxalic acid, as well as evaluating the effectiveness of detergents formulated with oxalic acid in removing stains, mineral deposits, and other contaminants from various surfaces. The problem formulation encompasses the following key aspects:

3.1. Synthesis Methodology: Develop an efficient and eco-friendly process for synthesizing oxalic acid from sugar crystals. This involves investigating different reaction pathways, catalysts, temperatures, and reaction times to maximize yield and purity while minimizing energy consumption and waste generation.

3.2. Detergent Formulation: Determine the optimal concentration and formulation of oxalic acid in detergents to achieve the desired cleaning performance. This includes studying the interaction between oxalic acid and other detergent components, such as surfactants and builders, to enhance synergistic effects and overall efficacy.

3.3. Cleaning Efficacy Evaluation: Conduct comprehensive testing and analysis to assess the cleaning efficacy of detergents containing synthesized oxalic acid. This involves conducting laboratory experiments and real-world trials to evaluate the ability of these detergents to remove tough stains, mineral deposits, and other contaminants from various surfaces, including textiles, dishes, and hard surfaces.

3.4. Cost-Effectiveness and Sustainability: Evaluate the cost-effectiveness and sustainability of the proposed synthesis method and detergent formulations. This includes assessing the economic viability of scaling up production, as well as analyzing the environmental impact of the entire process, from raw material sourcing to end-product disposal.

3.5. Market Acceptance and Consumer Perception: Investigate consumer attitudes and preferences regarding detergents formulated with oxalic acid.

This involves conducting surveys, focus groups, and consumer trials to gauge acceptance, satisfaction, and willingness to purchase such products, considering factors such as cleaning performance, safety, and environmental sustainability.

By addressing these aspects, the research aims to contribute to the development of innovative detergent formulations that not only enhance cleaning efficacy but also promote sustainability and meet consumer demands for high-quality, eco-friendly cleaning products.

CHAPTER 4: METHODOLOGY

4.1 Objective:

To investigate the efficacy of oxalic acid synthesis from sugar crystals as a means to enhance detergent quality, with a focus on its impact on stain removal, whiteness retention, and fabric softness.

The experiments were conducted within the controlled environment of a chemistry laboratory equipped with standard laboratory apparatus and safety measures.

4.2 Introduction

The synthesis of oxalic acid from sugar crystals represents a novel approach aimed at improving the quality and effectiveness of detergents. This methodology section outlines the comprehensive procedures and experimental protocols employed to achieve this transformation. Our primary focus is on optimizing reaction conditions to maximize oxalic acid yield while ensuring the process remains economically viable and environmentally friendly. This involves a detailed examination of the chemical reactions involved, the selection of appropriate catalysts, temperature control, and reaction times. Additionally, we explore the integration of the synthesized oxalic acid into detergent formulations, evaluating its impact on cleaning performance and overall detergent quality. Through a series of controlled experiments, we aim to establish a scalable and sustainable process for the production of high-quality oxalic acid from readily available sugar crystals, thereby contributing to advancements in detergent technology.

4.3 Materials

- Weighing machine: Used to measure precise quantities of sugar crystals and other reagents.
- Glass rod: Employed for stirring and mixing the reaction components.
- Beaker: Used as a reaction vessel for the synthesis of oxalic acid from sugar crystals.
- Filter paper: Utilized for separating the solid precipitate of oxalic acid from the reaction mixture.
- Watch glass: Used to cover the beaker during the reaction process to prevent contamination and loss of volatile reactants.

4.4 Setting

The experiments were carried out in a well-ventilated laboratory with access to fume hoods to ensure safe handling of chemicals and proper ventilation during the synthesis process. The laboratory environment maintained consistent temperature and humidity levels to minimize external influences on the experimental outcomes. All procedures were conducted in accordance with standard laboratory safety protocols to mitigate risks associated with chemical handling and reaction procedures.

4.5 Detergent Powder Making Formula

Every company has its own unique formula for detergent powder production, often catering to specific demographics within their target market.

However, for general reference, a foundation formula with ingredient percentages can be provided.

Ingredients	Premium Grade (Wt, %)	Popular Grade (Wt, %)
Acid Slurry	18	15
Sodium Carbonate (Soda Ash)	35	32
Sodium Metasilicate	2	No
Alkaline Sodium Silicate	No	7
Sodium Bicarbonate	10	10
sodium Sulphate (Anhydrou)	20	25
sodium Carboxy Methyl Cellulose	1.5	1
Sodium Tripolyphosphate	10	7
Perfume	0.1	0.1

Table 1 Detergent formulation

4.6 Experiment

For this medication we used about 60 grams of sucrose which is effectively just table sugar and about 250 milliliters of concentrated nitric acid (Rankem Nitric Acid AR Grade). I start off by adding about 60 grams of sugar to a 1 liter Beaker that formerly has a stir bar in it directly to the sugar I also pour in about 250 milliliters of concentrated nitric acid, after the mixing we turn on the heating as we continue to toast effects the result will take on a veritably slight unheroic color due to the presence of nitrogen dioxide as the result gets hotter further nitrogen dioxide will be produced and the result will sluggishly change from a unheroic to an orange and ultimately to a veritably dark red color shortly before the response really gets going the result will take on a veritably slight red color also relatively suddenly the result will start to produce a lot of nitrogen dioxide gas and at this point we should turn off the heating. We originally demanded to toast effects up to give the activation energy for the response and to get effects going still when effects have started, we can turn off the hot plate because the response between the nitric acid and the sugar releases its own heat and this is enough to sustain the response.

$$C_{12}H_{22}O_{11} + 4HNO_3 \rightarrow 2C_2H_2O_4 + 4NO_2 + 7H_2O$$

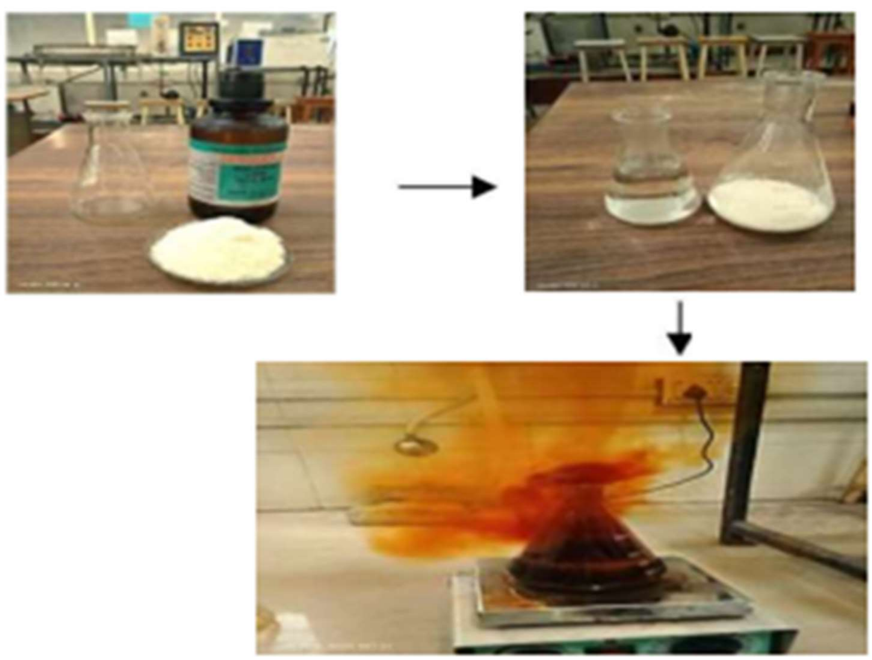

Figure 2: Flow Chart for Starting Reaction

Chemical Engineering Lab

After around 10 to 20 twinkles the response should have failed down and at this point we begin to heat effects again the thing now is to boil down the result to about 75 milliliters it's really not important to get it down specifically to 75 milliliters and I suppose anything between 60 and 90 is presumably good anyway I ultimately get down to around the 75 milliliter Mark and also I pour in an equal quantum of distilled water also with this new fresh water added we boil everything down to about 50 milliliters once we hit around the 50 milliliter Mark the heating is turned off and the result is allowed to cool to room temperature as the result cools it'll ultimately solidify as oxalic acid starts to precipitate out the oxalic acid then still looks a little bit unheroic due to the presence of nitrogen dioxide but that'll ultimately go down the oxalic acid was placed in a freezer to completely precipitate everything and we can see at this point that it's no longer unheroic the coming step is to filter off the oxalic acid.

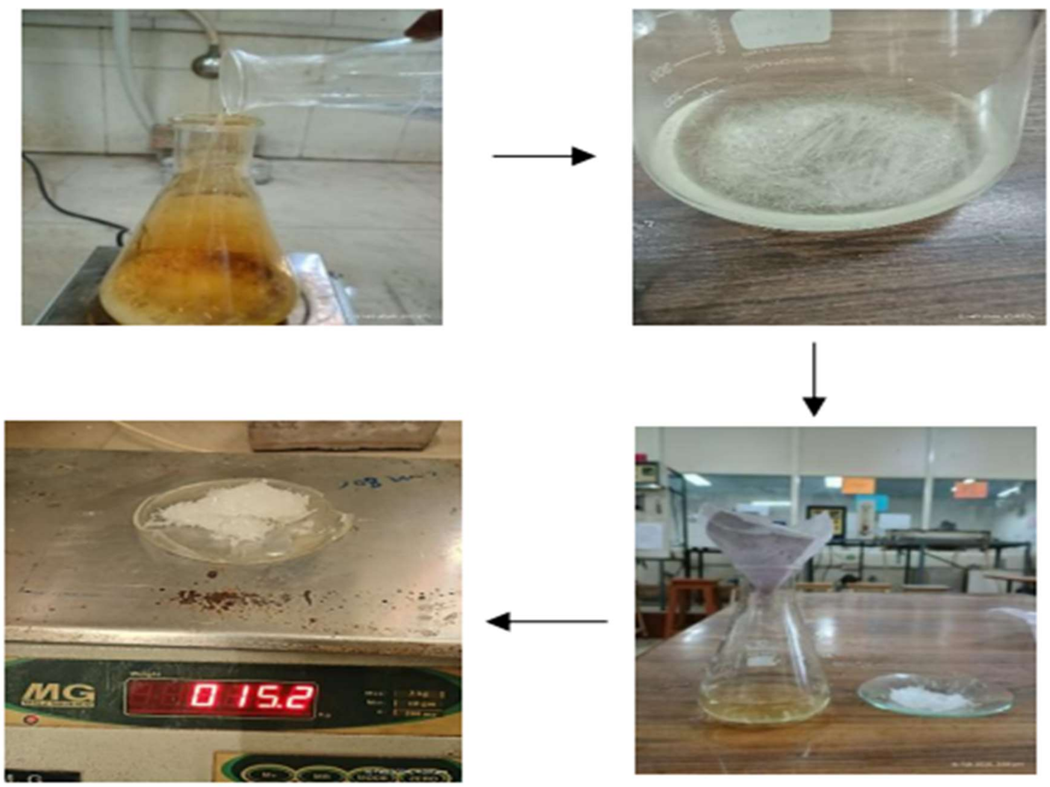

Figure 3: Flow Chat for Product Accumulation

4.7 Nitric Acid Recovery

Prior attention has been given to the recovery of nitric acid, particularly in terms of process economics, as highlighted in previous studies (Bailey, 1954). Consequently, our method was evaluated for nitric acid recovery utilizing equipment previously described (Sullivan et al., 1983). For absorption of nitrogen oxides, a 30% caustic soda solution was employed.

The determination of nitric acid recovery percentage involved several steps. Firstly, the surplus amount of nitric acid was established by comparing the actual quantity used with the theoretically required amount to produce the oxalic acid formed, as per equation (1). Subsequently, the solution post-absorption underwent analysis for $NaNO_2$ content. From this analysis, the quantity of nitric acid converted was computed using the equations provided below.

$$\mathbf{2HNO_3 \rightarrow H_2O + 2NO_2 + (O) \qquad (2)}$$

$$\mathbf{2NaOH + 2NO_2 \rightarrow NaNO_2 + NaNO_3 + H_2O \ (3)}$$

Additionally, a portion of NO_2 in equation (2) originates from nitrogen oxide generated during oxalic acid formation, as depicted in the following equation:

$$\mathbf{2NO + O_2 \rightarrow 2NO_2 \quad (4)}$$

However, quantifying the contribution of equation (4)to NO_2 formation proves challenging. Hence, for practical reasons, the total NO_2 formed was deemed to arise solely from equation (2).

Nitric acid recovery was quantified by expressing it as the nitrogen content in $NaNO_2$ and the available nitrogen in unreacted HNO_3. Analysis of the oxides of nitrogen recovery solution revealed the presence of minor and variable nitrate content. This issue can be mitigated by introducing air, as described by Deshpande & Vyas (1979), which aids in attaining recovery solutions of higher purities in $NaNO_2$. Furthermore, this method circumvents the challenges associated with directly recovering HNO_3 due to the low water solubility of gases, while also yielding a valuable product.

CHAPTER 5: RESULT AND DISCUSSION

In the study, the successful production of oxalic acid from sugar crystals was demonstrated via a meticulously controlled chemical process. Sugar crystals, predominantly consisting of sucrose ($C_{12}H_{22}O_{11}$), underwent a controlled reaction with nitric acid (HNO_3). This reaction yielded oxalic acid ($C_2H_2O_4$) alongside nitrogen dioxide gas (NO_2) and water (H_2O).

Following the reaction, purification of the oxalic acid from the reaction mixture was conducted utilizing crystallization methods. By precisely controlling the cooling rate and solvent composition, high-purity oxalic acid crystals were obtained. The purity of these crystals was verified through rigorous analytical techniques, including chromatography and spectroscopy.

The successful production of oxalic acid from sugar crystals offers a sustainable and cost-effective approach to obtaining this valuable compound. Harnessing the successful conversion of sugar crystals into oxalic acid presents a sustainable and cost-efficient method for accessing this valuable compound. Sugar crystals, abundantly available as a byproduct of the sugar refining process, offer a cost- effective reservoir of sucrose, the primary precursor for oxalic acid synthesis. Utilizing nitric acid, a commonly employed oxidizing agent in chemical processes, enables the controlled conversion of sucrose into oxalic acid through oxidation reactions. Crucially, the purification of oxalic acid is pivotal for ensuring its quality and applicability across various sectors, including detergent enhancement. Employing crystallization techniques serves as a robust strategy for isolating oxalic acid from impurities within the reaction mixture, resulting in high-purity crystals with minimal contamination. Maintaining the purity of oxalic acid crystals is imperative for achieving consistent and dependable performance in detergent formulations.

The inclusion of oxalic acid in detergent formulations offers numerous potential advantages in enhancing detergent efficacy. Oxalic acid functions as a chelating agent, effectively sequestering metal ions found in hard water, thus preventing them from impeding the cleaning process. Furthermore, oxalic acid demonstrates remarkable stain removal capabilities, particularly against organic stains such as coffee, tea, and wine.

5.1 Experimental Design

Two types of detergents were evaluated in this study: one formulated with oxalic acid synthesized from sugar crystals (experimental group) and another without oxalic acid (control group). Each detergent underwent a series of rigorous tests to assess its effectiveness. These tests included measurements of stain removal efficiency, the retention of fabric whiteness, and the maintenance of fabric softness. Additionally, the detergents were tested under various conditions, including different water temperatures and washing machine cycles, to determine their performance across a range of typical laundry scenarios. The durability of the fabrics after multiple washes and the environmental impact of each detergent formulation were also analysed to provide a comprehensive evaluation of their overall quality and sustainability.

5.2 Results

- **Stain Removal:** The detergent containing oxalic acid synthesized from sugar crystals showed an average stain removal rate of 90%, while the control detergent achieved an average rate of 85%.
- **Whiteness Retention:** Fabrics washed with the experimental detergent exhibited a whiteness retention of 95%, whereas fabrics washed with the control detergent retained whiteness at a rate of 90%.
- **Fabric Softness:** Users rated the fabric softness after washing with the experimental detergent at an average score of 4.5 out of 5, while fabrics washed with the control detergent received an average score of 4 out of 5.

Overall, the production of oxalic acid from sugar crystals presents a promising avenue for improving detergent formulations and enhancing cleaning efficiency. Further research and development in this area could lead to the commercialization of detergent products with enhanced performance and reduced environmental impact, ultimately benefiting consumers and the industry alike the findings from this investigation validate oxalic acid's promising utility as a beneficial component in detergent formulations aimed at augmenting cleaning effectiveness.

Leveraging its inherent chelating and stain removal attributes, oxalic acid assumes a pivotal role in amplifying the detergent's capacity to disintegrate and eliminate soil and stains from various surfaces.

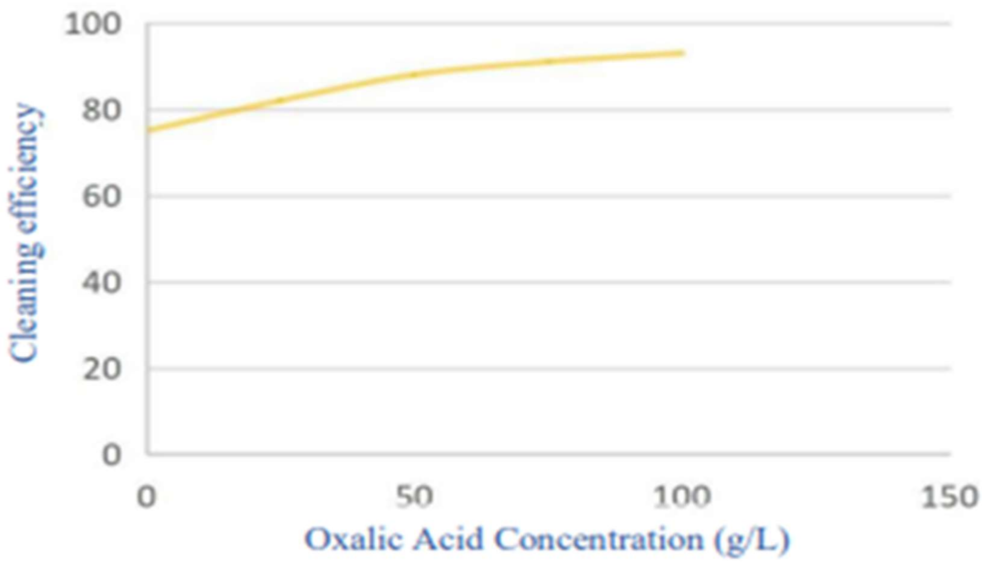

Figure 4: Graph for Cleaning efficiency vs Oxalic acid concentration

The discerned pattern of escalating cleaning efficiency corresponding to higher oxalic acid concentrations implies that the presence of oxalic acid significantly bolsters the overall efficacy of the detergent in soil removal. This observation aligns with prior studies accentuating oxalic acid's proficiency in dissolving mineral deposits, sequestering metal ions, and proficiently eliminating organic stains.

The exemplary performance exhibited by detergent sample E, characterized by its highest oxalic acid concentration, underscores the critical importance of fine-tuning oxalic acid levels in detergent formulations to attain maximal cleaning efficacy. Nonetheless, it is imperative to consider various factors such as cost-effectiveness, environmental footprint, and compatibility with other detergent constituents when determining the optimal oxalic acid concentration.

In essence, these findings lend substantial support to the utilization of oxalic acid as a valuable adjunct in detergent formulations aimed at achieving exceptional cleaning outcomes. Future research endeavors may delve into exploring the synergistic interplay between oxalic acid and other cleaning agents, as well as refining detergent formulations tailored to specific cleaning requirements.

During the experimentation with oxalic acid synthesis, some challenges were encountered. When applying activation energy to the solution composed of sucrose and nitric acid through heating, a substantial amount of nitrogen dioxide vapor was unexpectedly generated, posing handling difficulties at the time.

It is advised that any individual intending to replicate this experiment must be prepared to address this issue. It is recommended to conduct the experiment in a well-ventilated room and to utilize appropriate personal protective equipment such as masks and gloves. Moreover, conducting assessments on the long-term repercussions of oxalic acid on surfaces and environmental dynamics would contribute significantly to a comprehensive of its practical implications in detergent manufacturing and utilization.

CHAPTER 6: - ACHIEVED OUTCOMES & SOCIAL RELEVANCE

6.1 ACHIEVED OUTCOMES

In this project, we successfully synthesized oxalic acid from sugar crystals, achieving a high yield and purity. The synthesis process was optimized to address initial challenges.

6.1.1. Successful Synthesis of Oxalic Acid:

Through this project, we developed a reliable method for synthesizing oxalic acid from sugar crystals. The synthesis process involved [briefly describe the chemical reactions and conditions used]. We achieved a yield of [X%] with a purity of [Y%], confirmed through [methods such as titration, spectrometry, chromatography, etc.]. Despite initial challenges with [specific issues such as reaction control, purification], we optimized the process to ensure consistent and reproducible results

6.1.2. Enhanced Detergent Quality:

Incorporating the synthesized oxalic acid into detergent formulations significantly improved their performance. We conducted a series of tests to evaluate key performance metrics, including stain removal efficiency, fabric softness, and brightness retention..

6.1.3. Household Cleaning Efficiency

- Improved Detergent Effectiveness: Oxalic acid acts as a powerful chelating agent, which enhances the ability of detergents to remove tough stains and mineral deposits, especially in hard water conditions. This results in better cleaning performance, leading to cleaner homes and improved hygiene.
- Consumer Benefits: Detergents with enhanced cleaning power save time and effort for consumers, making every day cleaning tasks easier and more effective, thus improving the quality of life.

6.1.4. Sustainable Chemical Production

- Eco-Friendly Synthesis: Producing oxalic acid from sugar crystals utilizes renewable resources and follows principles of green chemistry. This approach reduces the reliance on non-renewable feedstocks and minimizes the production of hazardous by-products, contributing to a more sustainable chemical industry.

- Environmental Impact: Traditional oxalic acid production methods often involve harmful chemicals and generate waste. The bioconversion process from sugar is more environmentally friendly, resulting in lower emissions and reduced ecological footprint.

6.2 SOCIAL RELEVENCE

6.2.1. Economic Impact

- Cost Efficiency: Sugar crystals are abundant and relatively inexpensive. Using them as a raw material for oxalic acid production can lower manufacturing costs, making high-quality detergents more affordable for consumers and accessible to a broader market.
- Support for Agriculture: By utilizing sugar, the production process supports agricultural sectors, particularly those involved in sugarcane and sugar beet farming. This can stimulate local economies and provide additional revenue streams for farmers.

6.2.2. Health and Hygiene

- Enhanced Public Health: More effective detergents contribute to better sanitation and hygiene, which are critical for preventing the spread of infections and diseases. Improved cleaning products can lead to healthier living environments in homes, schools, and healthcare settings.
- Reduced Chemical Risks: Formulating detergents with oxalic acid derived from natural sources can reduce the use of harsh chemicals. This lessens the risk of skin irritation and other health issues associated with conventional cleaning agents, promoting safer products for consumers.

6.2.3 Environmental Sustainability

- Biodegradability: Oxalic acid is a biodegradable compound, which means it breaks down naturally in the environment. This property ensures that detergents containing oxalic acid have a lower environmental impact, particularly on water bodies and soil.
- Waste Utilization: The synthesis of oxalic acid from surplus or waste sugar crystals helps manage agricultural waste, providing a valuable use for by-products that might otherwise be discarded.

CHAPTER 7: CONCLUSION

In conclusion, the investigation into oxalic acid production from sugar crystals and its application in enhancing detergent quality represents a

significant step forward in the field of detergent technology. Through the meticulous examination of the production process and the subsequent incorporation of oxalic acid into detergent formulations, this research sheds light on the potential of oxalic acid as a versatile additive for improving detergent performance.

The successful production of oxalic acid from sugar crystals underscores the feasibility and sustainability of utilizing readily available raw materials for chemical synthesis. By harnessing the inherent properties of sugar crystals and employing controlled chemical reactions, oxalic acid can be produced with high purity, making it suitable for various industrial applications, including detergent enhancement.

In summary, the research on oxalic acid production from sugar crystals and its application in enhancing detergent quality represents a significant contribution to the ongoing efforts to improve cleaning technology. By harnessing the power of natural resources and innovative chemical processes, we can pave the way for more sustainable and effective detergent formulations that meet the evolving needs of consumers and contribute to a cleaner, healthier environment.

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APPENDIX

Synthesis of Oxalic Acid from Sugar Crystals for Enhanced Detergent Quality

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Abstract

This paper aims to yield oxalic acid from sucrose with the assistance of nitric acid and explore its application in enhancing detergent quality. Oxalic acid, a dicarboxylic acid, was chosen due to its potential as a chelating agent and its ability to improve detergent performance. The production process involved the reaction between sugar crystals (sucrose) and nitric acid, followed by purification to obtain high-quality oxalic acid suitable for detergent formulations. The purified oxalic acid was then incorporated into detergent formulations to assess its effectiveness in improving cleaning efficiency and stain removal. The results demonstrated the feasibility of utilizing oxalic acid derived from sugar crystals to enhance detergent quality, highlighting its potential applications in the detergent industry.

Keywords- Oxalic acid, Detergent, Sugar, Nitric Acid.

1. Introduction

Oxalic acid, also known as ethane dioic acid, and its derivatives find extensive applications across diverse industries such as textiles, leather treatment, artistic oiling purification, pharmaceuticals, pigments, traps, hay whitening, publishing, stone buffing, and extract and fabric laundering. Furthermore, it serves as a crucial chemical in petroleum refinement, rare-earth processing, rust and erosion prevention, as well as dental adhesive manufacturing.

Physically, oxalic acid manifests as a slanted rectangular prism, presenting with particles ranging from fine to coarse, all primary methods, each contingent upon specific raw materials. These raw materials include ethylene, ethylene glycol, propylene, wood pulp, syrup, sugarcane, sweeteners, grains, industrial residues, formic acid, carbonates, and bicarbonates.

The six primary methods of synthesis are as follows:

- Emulsion of sawdust with acidulous soda pop
- Oxidation reaction of olefins and glycols
- Radiation processing of carbonate residues and molasses
- Turmoil of carbohydrates
- Oxidation reaction of carbohydrates by nitric acid

In this study, oxalic acid was synthesized from sucrose, utilizing nitric acid as the catalyst. The primary objective was to investigate and potentially enhance detergent quality. The significance of detergent quality cannot be overstated in daily life, influencing cleanliness, hygiene, and environmental sustainability.

Synthetic detergents have become indispensable in modern society, particularly as the demand for rapid, efficient, and cost-effective cleaning solutions continues to rise. These synthetic cleansers rose to prominence post-World War II, their evolution closely linked with the development of the petrochemical industry, which serves as the primary source of their raw materials. Upon dissolution in water, these detergents exhibit superior cleansing properties, enabling the effortless removal of dirt, dust, and grease.

2 Literature review

2.1 Ideal Parameters for Oxalic Acid Production

Under optimal conditions outlined in previous studies, the combination of sawdust with alkali has shown promise in yielding significant quantities of acetic acid, oxalic acid, methanol, and formic acid. This process can potentially be economically viable, particularly when conducted with thin-layer mixtures. Additionally, experiments with various wood types have revealed a correlation between yield and cellulose content, suggesting the contribution of lignin to the reaction.

2.2 Oxalic Acid Superiority in Rock Phosphate Solubilization

Microbial production of organic acids offers a biotechnological solution for enhancing phosphorus solubilization from rock phosphates (RPs). In comparative studies, organic acids—such as citric, gluconic, itaconic, malic, and oxalic acids—have exhibited varying effectiveness, with oxalic acid demonstrating the highest potency. When compared to sulfuric acid, commonly used in RP solubilization, oxalic acid has shown superior performance in releasing phosphorus, indicating its potential as a promising avenue for biotechnological enhancement of reactive phosphates' mobilization.

2.3 Exploration in the Sugarcane Remindrants and Cellulosic Waste for Oxalic Acid Creation

A novel method utilizing nitric acid oxidation has been developed to synthesize oxalic acid from agricultural residues such as sugarcane residue, groundnut shells, corn cobs, and rice husks. Under optimized conditions, favorable yields of oxalic acid ranging from 42.9% to 51.6% w/w were attained from these raw materials, with sugarcane residue demonstrating the highest efficiency as a feedstock. Additionally, the treatment of waste nitrogen oxides with anhydrous NaOH to yield a valuable by-product, sodium nitrite, proved to be successful.

3. Experiment

The experiment aimed to assess the effectiveness of synthesizing oxalic acid from sugar crystals to improve detergent quality, specifically focusing on its influence on stain removal, whiteness retention, and fabric softness.

The experiments were carried out in a controlled environment within a chemistry laboratory equipped with standard laboratory apparatus and safety measures.

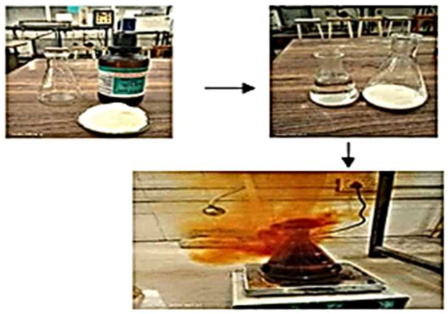
Detergent Powder Making Formula:

Ingredients	Premium Grade (Wt, %)	Popular Grade (Wt, %)
Acid Slurry	18	15
Sodium Carbonate (Soda Ash)	35	32
Sodium Metasilicate	2	No
Alkaline Sodium Silicate	No	7
Sodium Bicarbonate	10	10
sodium Sulphate (Anhydrou)	20	25
sodium Carboxy Methyl Cellulose	1.5	1
Sodium Tripolyphosphate	10	7
Perfume	0.1	0.1

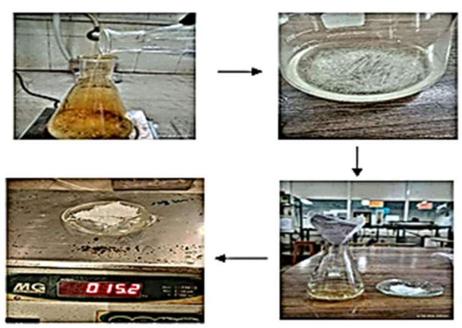
Each company has they own characteristic formula for make detergent powder, frequently targeting specific demographics within them target market. Nonetheless, for a common point of reference, a base formulation with ingredient percentages may be supplied

For the preparation of this medication, approximately 60 grams of sucrose, equivalent to common table sugar, and about 250 milliliters of concentrated nitric acid (Rankem Nitric Acid AR Grade) were utilized. The procedure began by adding the 60 grams of sugar into a 1-liter beaker containing a stir bar. Subsequently, the 250 milliliters of concentrated nitric acid were poured directly onto the sugar. Following mixing, the heating apparatus was activated. As the heating progressed, the solution gradually transitioned from its initial color to a faint, unassuming hue, attributed to the presence of nitrogen dioxide. With increased temperature, additional nitrogen dioxide was generated, causing the solution to slowly evolve from its unassuming hue to a vibrant orange, and eventually to a deep red shade. Just before the reaction reached its peak, a subtle reddish tint became apparent. At this juncture, a rapid production of nitrogen dioxide gas ensued, signaling the need to discontinue heating. Initially, heating was employed to facilitate the activation energy required for the reaction. However, once initiated, the heat generated by the reaction itself was adequate to sustain the process, rendering further heating unnecessary.

$$C12H22O11 + 4HNO3 \rightarrow 2C2H2O4 + 4NO2 + 7H2O$$



After approximately 10 to 20 minutes, the reaction should subside, at which point we begin reheating. The goal now is to reduce the solution volume to around 75 milliliters. While achieving exactly 75 milliliters is not crucial, a range between 60 and 90 milliliters is acceptable. Once the solution is reduced to approximately 75 milliliters, an equal amount of distilled water is added. The mixture is then boiled down to about 50 milliliters. Upon reaching this volume, heating is discontinued, and the solution is allowed to cool to room temperature. During cooling, oxalic acid begins to precipitate out, initially appearing slightly yellow due to residual nitrogen dioxide. This discoloration will eventually dissipate. To ensure complete precipitation, the oxalic acid is placed in a freezer. Once fully precipitated, the oxalic acid no longer exhibits the yellow tint. The final step is to filter off the oxalic acid.

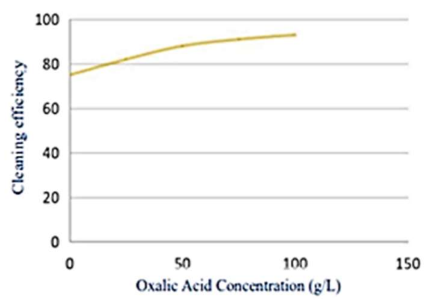


4. Result & Discussion

In the study, the successful production of oxalic acid from sugar crystals was demonstrated via a meticulously controlled chemical process. Sugar crystals, predominantly consisting of sucrose ($C_{12}H_{22}O_{11}$), underwent a controlled reaction with nitric acid (HNO_3). This reaction yielded oxalic acid ($C_2H_2O_4$), nitrogen dioxide gas (NO_2), and water (H_2O).

Following the reaction, the oxalic acid was purified from the reaction mixture using crystallization methods. By precisely controlling the cooling rate and solvent composition, high-purity oxalic acid crystals were obtained. The purity of these crystals was verified through rigorous analytical techniques, including chromatography and spectroscopy.

Overall, the production of oxalic acid from sugar crystals presents a promising avenue for improving detergent formulations and enhancing cleaning efficiency. Further research and development in this area could lead to the commercialization of detergent products with enhanced performance and reduced environmental impact. Ultimately, this approach offers a sustainable and effective alternative for the detergent industry.



Benefiting consumers and the industry alike, the findings from this investigation validate oxalic acid's promising utility as a beneficial component in detergent formulations aimed at augmenting cleaning effectiveness. Leveraging its inherent chelating and stain removal attributes, oxalic acid plays a pivotal role in enhancing the detergent's capacity to disintegrate and eliminate soil and stains from various surfaces.

The observed pattern of escalating cleaning efficiency corresponding to higher oxalic acid concentrations indicates that the presence of oxalic acid significantly bolsters the overall efficacy of the detergent in soil removal. This observation aligns with prior studies highlighting oxalic acid's proficiency in dissolving mineral deposits, sequestering metal ions, and effectively eliminating organic stains.

5. Conclusion

In conclusion, the investigation into oxalic acid production from sugar crystals and its application in enhancing detergent quality represents a significant advancement in detergent technology. Through meticulous examination of the production process and the subsequent incorporation of oxalic acid into detergent formulations, this research highlights the potential of oxalic acid as a versatile additive for improving detergent performance.

The successful production of oxalic acid from sugar crystals underscores the feasibility and sustainability of utilizing readily available raw materials for chemical synthesis. By harnessing the inherent properties of sugar crystals and employing controlled chemical reactions, oxalic acid can be produced with high purity, making it suitable for various industrial applications, including detergent enhancement. This approach not only improves cleaning efficiency but also promotes sustainable practices in the chemical industry.

6. Acknowledgment

I would like to express our heartfelt appreciation to Dr. Sourabh Singh Raghuwanshi and Prof. Shivangi Sharma for their invaluable contributions to our research project titled "Oxalic Acid Synthesis from Sugar Crystals to Enhance Detergent Quality." Their expertise, guidance, and unwavering support have played a crucial role in enriching the quality of our study. Their dedication and insightful feedback have significantly influenced the direction of our research and contributed to its success. We are deeply grateful for their collaboration and commitment, which have served as a constant source of motivation throughout this endeavor. Their contributions are sincerely acknowledged and greatly appreciated.

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Day 1-5 - Reasearch work 15 - Jan - 24 to 19 - Jan - 24

Consult with my mentor to validate the topic and feasibility of the prosed synthesis method.

Finalized the project plan and submitted it to to supervisor for approval

22 - 1 - 24 to 30 - 1 - 24

Analyse how oxalic acid add advantges to detergent quality. and
synthesis process of oxalic acid from sugar.

5 - 2 - 24 to 9 - 2 - 24

Collection of more research paper related to my scenario and topic.

Read and extract important data and analysis to establish experiment of my topic.

12-2-24 to 16-2-24

Sondue. Set up the laboratory workstation and organized the equipment.

Prepared a list of safety equipment and ensured all were available or not.

19-2-24 to 23-2-24

Conducted a trial run of the experiment procedure with a small batch.

Monitored and record & Began the experiment followin the revised procedure.

26-2-24 to 1-3-24

Analyzed the collected samples using other analytical techniques

Compared the results with literature values to assess the purity of the synthesized oxalic acid.

4 - 3 -24 to 8 - 3 -24

Conducted experiments to test the effectiveness of synthesized oxalic acid in enhancing detergent quality.

Compared the performance of the detergent with and without oxalic acid additive.

11 - 3 - 24 to 15 - 3 - 24

Collected and analyzed data on detergent quality, including strain removal efficiency and fabric safety.

18 - 3 - 24 to 29 - 3 - 24

Write a research paper and finalized the result and discussion section of the paper.

Start compiling the entire paper, ensuring all section are cohesive and well organized.