ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 12| Issue: 6| June 2026|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2026: 8.753 || ISI Value: 1.188

SYNTHESIS AND ANALYSIS OF BENZIL FROM BENZOIN

Mr. Aniket Sawale[1], Mr. Avinash Chavan [2],
Dr. Lalita Bhagure[3].Mr. Ganesh Gore[4]
Raosaheb Patil Danve College of Pharmacy, Badnapur, Jalna. 431202
[1,4]Student of Bachelor in Pharmacy, Dr. Babasaheb Ambedkar Technological University, Raigad, Lonere
[2,3]Department of Pharmacy, Faculty of Pharmacy, Dr. Babasaheb Ambedkar Technological University, Raigad, Lonere

1.ABSTRACT
Benzil ($C_{14}H_{10}O_2$) is an important aromatic diketone widely used as an intermediate in organic synthesis, pharmaceuticals, dyes, and photochemical studies. It is commonly synthesized by the oxidation of benzoin ($C_{14}H_{12}O_2$), an a-hydroxy ketone. The present project focuses on the synthesis of benzil from benzoin using concentrated nitric acid as an oxidizing agent and the subsequent analysis of the synthesized product.

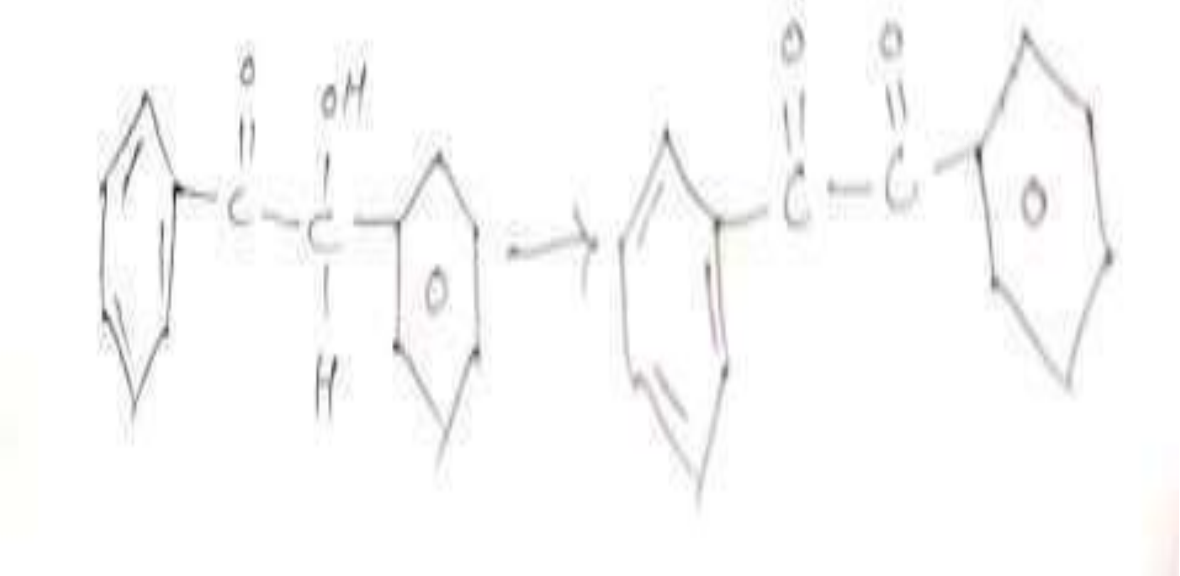
The reaction involves oxidation of the secondary alcohol group present in benzoin to a carbonyl group, resulting in the formation of benzil. The synthesized product is purified through recrystallization and characterized by determination of melting point and percentage yield. The experiment demonstrates fundamental concepts of oxidation reactions, purification techniques, and analytical characterization.

The study provides practical knowledge of organic synthesis and highlights the importance of benzil as a versatile compound in chemical research and industrial applications.

KEYWORDS: *Benzoin, Benzil, Organic Synthesis, Oxidation Reaction, Aromatic Ketone, aDiketone, Nitric Acid Oxidation, Green Chemistry.*

2. INTRODUCTION
Organic synthesis is a fundamental branch of chemistry that involves the preparation of chemical compounds through controlled chemical reactions. Among various organic transformations, oxidation reactions play a significant role in converting alcohols into aldehydes, ketones, or carboxylic acids.

The reaction can be represented as follows:



Benzil ($C_{14}H_{10}O_2$) is an important aromatic diketone widely used as an intermediate in pharmaceutical research, polymer chemistry, photochemistry, and heterocyclic synthesis. It is commonly prepared by oxidation of benzoin ($C_{14}H_{12}O_2$), an α-hydroxy ketone.

Benzoin contains both hydroxyl (-OH) and carbonyl (>C=O) functional groups. Upon oxidation, the hydroxyl group is converted into a carbonyl group, resulting in the formation of benzil, which contains two ketone functional groups.

Chemical Reaction

$C_{14}H_{12}O_2 + [O] \rightarrow C_{14}H_{10}O_2 + H_2O$

Importance of Benzil

1. Intermediate in pharmaceutical synthesis.
2. Used in preparation of heterocyclic compounds.
3. Photoinitiator in polymer chemistry.
4. Reagent in organic transformations.
5. Starting material for benzilic acid synthesis.

Benzil possesses a bright yellow color due to its conjugated diketone structure and exhibits a melting point of approximately 94–96°C.

3. LITERATURE REVIEW

The synthesis of benzil from benzoin is one of the most widely studied oxidation reactions in organic chemistry. Over the years, researchers have developed various oxidation methods to improve yield, selectivity, and environmental sustainability.

Developments from 2001–2005

Conventional oxidizing agents such as nitric acid, potassium dichromate, copper sulfate, and ferric chloride were widely employed. Reactions were generally performed under reflux conditions using ethanol or acetic acid as solvents.

Microwave-assisted synthesis emerged as an efficient technique, reducing reaction time and improving yields. Ionic liquids were also explored as environmentally friendly reaction media.

Progress from 2006–2010

Researchers focused on catalytic oxidation systems and green chemistry approaches. Hypervalent iodine reagents and DMSO-based oxidations gained popularity because of reduced hazardous by-products and improved selectivity.

Polymer-supported oxidizing reagents were introduced to simplify catalyst recovery and improve recyclability.

Research Trends from 2011–2015

Oxovanadium Schiff-base complexes and hydrogen peroxide-based systems became important alternatives to traditional oxidants. These methods offered excellent yields with minimal environmental impact.

Advanced analytical methods such as GC-MS, IR spectroscopy, and UV-visible spectroscopy were increasingly used for product characterization.

Recent Developments (2016–2025)

Recent research emphasizes sustainable oxidation methods, including:

- Solvent-free synthesis
- Microwave-assisted oxidation
- Catalytic oxidation systems
- Green oxidizing agents
- Continuous flow synthesis

4. AIM AND OBJECTIVES

Aim

To synthesize and analyze benzil from benzoin through oxidation using concentrated nitric acid.

Objectives

1. To synthesize benzil from benzoin.
2. To study oxidation of α-hydroxy ketones.
3. To understand the reaction mechanism involved.
4. To perform oxidation under controlled laboratory conditions.
5. To isolate and purify benzil.
6. To determine percentage yield.

5. PLAN OF WORK

Step 1

Literature survey on benzoin oxidation.

Step 2

Procurement of chemicals and glassware.

Step 3

Oxidation of benzoin using nitric acid.

Step 4

Isolation of crude benzil.

Step 5

Purification by recrystallization.

Step 6

Determination of yield.

Step 7

Result.

6. MATERIALS AND METHODS

Materials Required

Chemicals

1. Benzoin
2. Concentrated Nitric Acid
3. Ethanol
4. Distilled Water
5. Acetone

Apparatus

1. Round-bottom flask

2. Water bath
3. Condenser
4. Beakers
5. Measuring cylinder
6. Funnel
7. Filter paper
8. Melting point apparatus

Principle

The synthesis of benzil from benzoin is based on oxidation of an α-hydroxy ketone into an αdiketone. Benzoin contains both hydroxyl and carbonyl functional groups, whereas benzil contains two carbonyl groups.

Nitric acid acts as a strong oxidizing agent and converts the secondary alcohol group of benzoin into a ketone group, producing benzil and water.

Reaction:

$C_{14}H_{12}O_2 + [O] \rightarrow C_{14}H_{10}O_2 + H_2O$

The yellow color of benzil is due to its conjugated diketone structure.

7. EXPERIMENTAL PROCEDURE

Step 1: Oxidation

1. Take 5 g benzoin in a round-bottom flask.
2. Add 15 mL concentrated nitric acid.
3. Heat on a water bath for 30–45 minutes.
4. Observe evolution of brown nitrogen dioxide fumes.
5. Continue heating until the reaction is complete.

Step 2: Cooling

1. Cool the reaction mixture.
2. Pour into cold water.
3. Yellow crystals of benzil separate out.

Step 3: Filtration

1. Filter the precipitated crystals.
2. Wash thoroughly with distilled water.

Step 4: Recrystallization

1. Dissolve crude benzil in hot ethanol.
2. Cool slowly to room temperature.
3. Collect pure benzil crystals by filtration.

Step 5: Drying

Dry the crystals and determine their weight.

8. ANALYTICAL STUDIES

Percentage Yield

Percentage Yield = (Actual Yield / Theoretical Yield) × 100

Experimental Data

Benzoin Taken = 4.0 g
Benzil Obtained = 4.2 g
Percentage Yield = 81.81%

Melting Point

Observed Melting Point = 95°C
Literature Value = 94–96°C

The close agreement with the literature value indicates high purity of the synthesized benzil.

Calculation

Name of synthesized compound- Bonzil.
Molecular Formula- $C_{14}\ H_{10}O_2$
Molecular Weight- 210
Theoretical Yield: 0.009 g
Practical Yield: 0.07 g

Percentage Yield: 77%

9. RESULTS AND DISCUSSION

Observations

Physical Appearance

- Color: Yellow
- Nature: Crystalline solid

Mechanism of Oxidation

1. Protonation of hydroxyl group.
2. Formation of reactive intermediate.
3. Removal of hydrogen atoms.
4. Formation of diketone structure.

The reaction successfully converted benzoin into benzil through oxidation of the secondary alcohol group.

Discussion

The synthesized product exhibited characteristic yellow crystals and a melting point close to the reported literature value. The percentage yield of 81.81% indicates efficient conversion under the experimental conditions.

The experiment successfully demonstrated oxidation reactions, purification techniques, and analytical characterization methods.

10. APPLICATIONS, ADVANTAGES AND FUTURE SCOPE

Applications of Benzil

Pharmaceutical Applications

- Anticonvulsant drug synthesis
- Anti-inflammatory agents
- Antimicrobial compounds
- Anticancer molecules

Heterocyclic Synthesis

- Imidazoles
- Quinoxalines
- Benzodiazepines
- Pyrazines

Industrial Applications

- Photoinitiators
- Polymer chemistry
- Dye intermediates
- Specialty chemicals

Advantages

1. Simple experimental procedure.
2. Good percentage yield.
3. Educational importance.

4. Industrial significance. 5. Cost-effective process.

Future Scope
1. Drug development.
2. Green chemistry approaches.
3. Advanced polymer applications.
4. Nanotechnology applications.
5. Sustainable industrial production.
6. Continuous flow synthesis.
7. Academic and research applications.

Precautions
1. Handle concentrated nitric acid carefully.
2. Perform the reaction in a fume hood.
3. Avoid overheating.
4. Wear gloves and safety goggles.
5. Wash product thoroughly to remove acid traces.

11. CONCLUSION AND REFERENCES

Conclusion

The present study successfully synthesized benzil from benzoin through oxidation using concentrated nitric acid. The product was isolated, purified, and characterized by melting point determination and percentage yield analysis.

The observed melting point of 95°C matched the literature value of 94–96°C, confirming successful synthesis and purity of the product. The percentage yield obtained was 81.81%, indicating efficient conversion of benzoin into benzil.

The experiment provided valuable knowledge regarding oxidation reactions, purification methods, and analytical characterization techniques. Benzil remains an important compound in pharmaceutical, industrial, and research applications.

12. REFERENCES

1. ***Depreux, P.; Bethegnies, G.; Marcincal-Lefebvre, A.***
   - *Synthesis of benzil from benzoin with copper(II) acetate.*
   - *Journal of Chemical Education, 1988, 65(6), 553.*
   - *DOI: 10.1021/ed065p553*
   - *Describes an undergraduate laboratory synthesis of benzil by oxidation of benzoin using copper(II) acetate.*
2. ***Crouch, R. D.; Holden, M. S.; Burger, J. S.***
   - *Oxidation of Benzoin to Benzil Using Alumina-Supported Active MnO_2.*
   - *Journal of Chemical Education, 2001, 78(7), 951.*
   - *DOI: 10.1021/ed078p951*
   - *Presents a safer and efficient laboratory oxidation method using supported manganese dioxide.*
3. ***Weiss, M.; Appel, M.***
   - *The Catalytic Oxidation of Benzoin to Benzil.*
   - *Journal of the American Chemical Society, 1948, 70(11), 3666–3667. DOI: 10.1021/ja01191a036*
   - *Classic paper describing catalytic oxidation of benzoin to benzil.*
4. ***Michaelis, L.; Fetcher Jr., E. S.***
   - *Two-Step Oxidation of Benzoin to Benzil.*
   - *Journal of the American Chemical Society, 1937, 59(7), 1246–1249.*
   - *DOI: 10.1021/ja01286a024*
   - *Early mechanistic investigation of benzoin oxidation.*
5. ***Alsalim, T. A.; Hadi, J. S.; Ali, O. N.; Abbo, H. S.; Titinchi, S. J. J.***
   - *Oxidation of benzoin catalyzed by oxovanadium (IV) Schiff base complexes.*
   - *BMC Chemistry, 2013, 7, Article 3.*
   - *DOI: 10.1186/1752-153X-7-3*
   - *Discusses modern catalytic oxidation methods and optimization of benzil production.*