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Benzilic Acid Rearrangement

Practical 11 - Supervised synthesis and reaction-record practical

Aim

To prepare or assess benzilic acid by rearrangement of benzil and explain its reaction, isolation and characterisation.

Principle

Benzil undergoes hydroxide-promoted rearrangement to benzilate; the authorised acid work-up gives benzilic acid.

Hydroxide addition to an alpha-diketone is followed by phenyl migration and proton transfer, producing an alpha-hydroxy carboxylate.

Materials and Requirements

- Approved microscale reaction SOP and reagent specifications
- Supervised hood, temperature control, glassware and method-specific work-up equipment
- TLC references, balance and appropriate melting-point or spectral methods
- Approved method or teaching-data pack and a dated record sheet

Procedure

1. Define the preparation or dataset, study question and method version. Record identities, units and the criteria to be used before examining the outcome.
2. Draw the reaction and mechanism, identify stoichiometry, limiting reagent and possible side products. Enter the authorised quantities, addition order and temperature/time limits in the record.
3. Carry out the approved alkaline transformation, then isolate the acid through the controlled work-up specified by the instructor.
4. Monitor progress by the prescribed TLC or other analytical method, retaining the starting-material comparison.
5. Isolate and purify by the authorised work-up, record dry mass and examine identity and purity by complementary methods.
6. Retain the original observations and calculations. State deviations, missing information and the limits of the conclusion; do not replace measured values with expected results.

Observations and Record

Enter actual measurements or the supplied teaching data. Record the method, material identity, conditions and units.

Stage / preparation	Conditions / observation	Analytical evidence	Mass / yield
Starting materials	Identity / quantities	Reference evidence	Calculate mol
Reaction progress	Actual time / temperature	TLC or assay	Record
Purified product	Appearance	Identity / purity	Dry mass

Calculations

- Theoretical product mass = limiting-reactant moles x stoichiometric product ratio x product molar mass
- Isolated yield (%) = dry isolated product mass / theoretical product mass x 100
- Rf = zone migration / solvent-front migration

Worked Example

Illustrative 1:1 conversion from 10.0 mmol limiting reagent to a product of molar mass 228.24 g/mol gives 2.2824 g theoretical product. A dry isolated mass of 1.7118 g corresponds to 75.0% yield.

Use the actual reaction stoichiometry, salt or solvate form and purity basis; this illustration is not an expected experimental result.

Mechanism and identity record

• Hydroxide addition to an alpha-diketone is followed by phenyl migration and proton transfer, producing an alpha-hydroxy carboxylate.

• Compare the loss of diketone character with carboxylic-acid and hydroxyl evidence; distinguish benzilic acid from unchanged benzil.

Result and Interpretation

• Report isolated yield and the independent identity/purity observations.

• Compare the loss of diketone character with carboxylic-acid and hydroxyl evidence; distinguish benzilic acid from unchanged benzil.

Precautions

• Use controlled alkaline and acid handling; account for heat during neutralisation.

• Use the institution-approved SOP and trained supervision for reactive additions, heating and work-up.

• Do not infer purity from yield or a single TLC zone.

Viva Questions and Answers

What determines theoretical yield?

The limiting reagent and balanced reaction stoichiometry.

How is conversion different from isolated yield?

Conversion measures reactant consumption; isolated yield also reflects selectivity and recovery losses.

Why use complementary identity tests?

A single physical or chromatographic observation may not distinguish impurities or isomers.

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