3. Organic Preparations (Postgraduate Level)

Experiment: PG-1

COENZYME CATALYZED BENZOIN CONDENSATION
(Thiamine hydrochloride catalyzed synthesis of benzoin)

Conventional Procedure:

\[
\begin{align*}
2 \text{CHO} & \xrightarrow{\text{NaCN}} \xrightarrow{\text{EtOH/H}_2\text{O}} \text{C} \equiv \text{CH} - \text{OH} \\
& \xrightarrow{\text{NaCN}} \xrightarrow{\text{EtOH/H}_2\text{O}} \text{C} \equiv \text{CH} - \text{OH}
\end{align*}
\]

Non-green Component:
Involves the use of highly poisonous sodium cyanide

Alternate Green Procedure:

\[
\begin{align*}
2 \text{CHO} & \xrightarrow{\text{Thiamine hydrochloride}} \xrightarrow{\text{Thiamine hydrochloride}} \text{C} \equiv \text{CH} - \text{OH} \\
& \xrightarrow{\text{Thiamine hydrochloride}} \xrightarrow{\text{Thiamine hydrochloride}} \text{C} \equiv \text{CH} - \text{OH}
\end{align*}
\]

Chemicals Required:

- Benzaldehyde - 10 g
- Thiamine hydrochloride - 1.75 g
- Sodium hydroxide - 5 ml (2 M)
- Ethanol - 15 ml

The thiamine hydrochloride (1.75 g) was dissolved in water (about 5 ml) in a 50 ml round bottom flask. Ethanol (95%, 15 ml) was added and the solution was cooled by swirling the flask in an ice water bath. Meanwhile, sodium hydroxide solution (5 ml) was cooled in a small conical flask in an ice bath. Then over a period of about 10 min the sodium hydroxide solution was added dropwise to the thiamine solution. Fresh benzaldehyde (10 ml) was added to the reaction mixture. The mixture was heated gently on a water bath for about 90 min. The mixture was cooled to room temperature and then in ice bath to induce crystallization of the
benzoin. If product separated as oil, the mixture was reheated until it was once again homogeneous. Then it was allowed to cool more slowly than before. Scratching of the flask with a glass rod may induce crystallization.

Yield - 6 g (30%)

Melting point of benzoin - 135 °C

**Caution:**

Benzaldehyde used in the experiment should be free of benzoic acid

Thiamine hydrochloride should be kept in refrigerator when it is not in use.

**Green Context:**

- Hazardous and poisonous cyanide ion is replaced by thiamine hydrochloride.
- Reaction is effected at a lower temperature.

**Mechanism:**