FINAL ASSIGNMNET

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Submitted To:

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Subject:

Biochemical Engineering

Industrial Bioprocess: Kombucha (Fermented Tea Beverage)

1. Introduction

Kombucha is a fermented tea beverage that is slightly effervescent, tangy, and rich in probiotics. It is produced by fermenting sweetened tea using a Symbiotic Culture of Bacteria and Yeast (SCOBY). Unlike cheese or yogurt, kombucha is a non-dairy, beverage-based fermented product.

2. Raw Materials Required

- Starter liquid (kombucha from a previous batch) to maintain pH
- Fermentation vessels (glass/stainless steel)
- Cheesecloth or breathable fabric to cover fermentation tank
- Rubber bands or lids for securing cloth
- Black or Green Tea
- Sucrose (table sugar)
- Distilled Water
- SCOBY (Symbiotic Culture of Bacteria and Yeast)

3. Biochemical Reactions

These reactions occur in a sequential and symbiotic manner, where yeast initially breaks down the sugar into ethanol and carbon dioxide, and the acetic acid bacteria subsequently oxidize ethanol into acetic acid. Minor by-products like gluconic acid, glucuronic acid, and various enzymes are also produced during fermentation, contributing to the health benefits of kombucha.

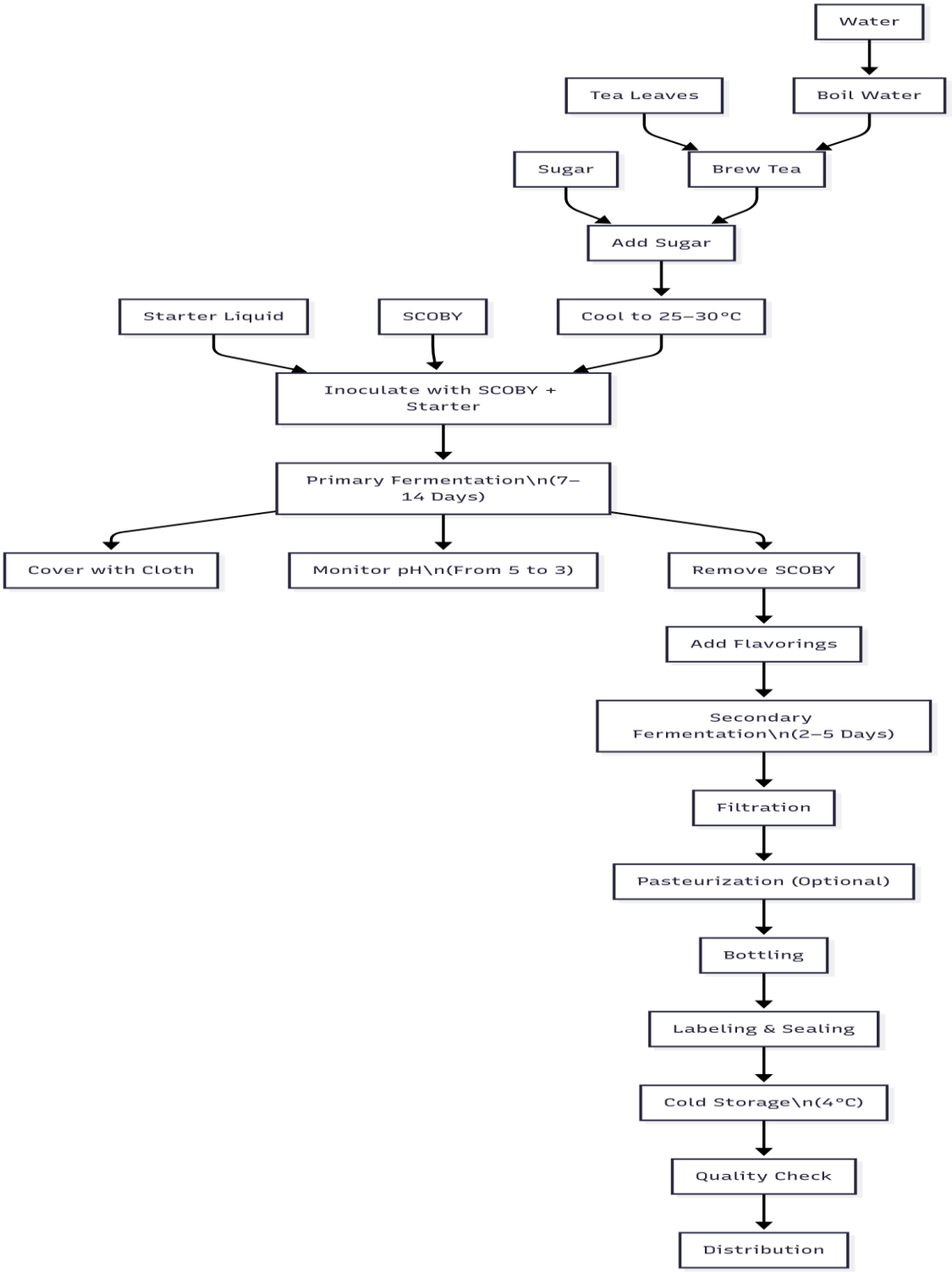
Step 1: Yeast fermentation of sugar to ethanol and carbon dioxide:

$C_6H_{12}O_6$ (Glucose) → 2 C_2H_5OH (Ethanol) + 2 CO_2

Step 2: Acetic acid bacteria oxidation of ethanol to acetic acid:

$C_2H_5OH + O_2 \rightarrow CH_3COOH$ (Acetic Acid) + H_2O

BLOCK DIAGRAM:



4. Fermentation Conditions

The fermentation environment must be clean and undisturbed. Light exposure should be minimal as it can affect the microbial activity. The vessel should be placed in a well-ventilated area to allow oxygen availability for aerobic bacteria.

- Temperature: 25°C to 30°C
- Fermentation Time: 7 to 14 days
- pH: Starts around 5, decreases to around 3
- Pressure: Atmospheric
- Stirring: Gentle or static

5. Microorganisms Involved

Other common yeasts include Brettanomyces, Zygosaccharomyces, and Candida species. Acetic acid bacteria such as Gluconacetobacter and Komagataeibacter are also involved in the formation of the cellulose mat and acid production.

- Yeast (e.g., Saccharomyces cerevisiae): Converts sugar into ethanol and CO_2
- Acetic Acid Bacteria (e.g., Acetobacter xylinum, Gluconobacter): Converts ethanol into acetic acid

6. Industrial Process Steps

1. Quality Control: pH, alcohol content, microbial testing
2. Labeling and Distribution: Bottles are labeled with batch and expiry date
3. Cold Storage: Final products are stored at 4°C to slow down residual fermentation
4. Tea Brewing: Boil water and steep tea leaves for 10 minutes
5. Sugar Addition: Add and dissolve sugar into the hot tea
6. Cooling: Allow the sweetened tea to cool to 25–30°C
7. Inoculation: Add SCOBY into the cooled tea
8. Fermentation: Transfer to fermentation vessels, leave for 7–14 days
9. Filtration: Remove SCOBY and filter the liquid
10. Bottling: Bottle under sterile conditions
11. Optional Flavoring: Add natural flavorings (ginger, fruits)
12. Packaging and Storage

7. Final Product Characteristics

- May contain organic acids (acetic, gluconic, glucuronic acids)
- Contains B-vitamins (B1, B6, B12) and antioxidants
- Natural carbonation due to trapped CO_2
- Slightly alcoholic (<0.5%) unless pasteurized
- Slightly fizzy and tangy taste
- pH around 3.2
- Contains probiotics and trace amounts of ethanol (<0.5%)
- Shelf life can be extended through refrigeration

8. Sterilization Steps

All personnel handling the product should wear gloves and masks to maintain hygiene standards. Cleaning protocols must be established for fermenters and bottling units to prevent microbial contamination.

- Use boiled or distilled water for tea brewing
- All equipment should be cleaned with food-grade sanitizer
- Bottles should be sterilized before packaging
- Avoid contamination during inoculation and bottling stages