Chapter 1

Introduction

1.1 Background

Kombucha is a fermented tea beverage produced by fermenting sweetened tea with a symbiotic culture of bacteria and yeast (SCOBY). Throughout 7 to 10 days, the process of fermentation produces a range of organic acids that shape kombucha’s distinctive flavor (Villarreal-Soto et al., 2018). Aside from the flavor that fermentation gives to kombucha, it also contributes to the growth of phenolic and antioxidant content, which is defined by Selvaraj & Gurumurthy. (2022) as living microbes that contribute positively to intestinal health, immunity, nutrition, metabolism, and physiology. Due to kombucha's probiotic nature, health-aware consumers tend to seek kombucha products for their health benefits. According to Laureys et al. (2020), kombucha's popularity has risen significantly due to its claims of health benefits when consumed. Another study by Prajapati et al. (2024) states that the kombucha market was valued at USD 2.64 billion in 2021 and is projected to grow to USD 9.76 billion by 2030, with a compound annual growth rate (CAGR) of 15.6%. With both AAB and LAB producing organic acids mentioned above, not only do they provide both health benefits and a safer fermentation environment (Villarreal-Soto et al., 2018). However, Black tea leaves can contain up to 3,260 µg/g of aluminum, with infusions reaching 13.0 µg/mL depending on brewing. Around 31.6% of this aluminum transfers to the drink. While only <1% is absorbed in the body, long-term high intake, especially over the WHO's recommended 8.57 mg/day for a 60 kg adult. Aluminum exposure through tea has been linked to potential health risks such as osteomalacia and neurodegenerative disorders like Alzheimer's. In response to this issue, an alternative medium for kombucha that has emerged is the use of fruits, such as berries and tropical fruits. Before the start of this project, a preliminary consumer online- survey was conducted to assess flavor preferences for potential kombucha analogues. The results revealed that 60% (out of 72) of respondents expressed interest in berry-based kombucha, with 20% specifically favoring strawberry as the preferred medium. Based on this insight, strawberry was selected as the fermentation substrate. Based on research by Zhao et al. (2021) shows that strawberry juice, when fermented, becomes more appealing due to its enhanced health benefits and minor sensory qualities. Fermented strawberry juice more than doubled its antioxidant capacity (T-AOC from 4.15 ± 0.81 to 8.43 ± 0.27 U/mL), increased T-SOD activity by 33.33%, and exhibited strong antibacterial effects and preservation qualities. However, an issue in developing fermented beverages like kombucha is the preservation of phenolic content, and their short shelf life, primarily due to oxidative stress and high acidity due to prolonged fermentation (Chakravorty et al., 2016). Phenolic compounds such as flavonoids and anthocyanins are highly sensitive to degradation caused by oxygen, temperature, light, and pH fluctuations (Ribeiro et al., 2019). A study by La Torre et al. (2021) found that after four months of storage at 4°C, the phenolic content of kombucha decreased significantly, and its antioxidant capacity diminished. To address this, spray drying is used as an encapsulation technique.

Spray drying is commonly employed to enhance the stability and shelf life of bioactive compounds in functional beverages. Carrier agents form a physical matrix that entraps phenolic molecules, thereby acting as a barrier against oxidative reactions (Ballesteros et al., 2017). This matrix reduces oxygen diffusion and protects phenolics from environmental stressors. Additionally, carriers regulate the microenvironment around the core materials by reducing water activity and buffering pH changes, both of which contribute to the stability of antioxidants (Pashazadeh et al., 2021). Thermal degradation is another concern during spray drying, as inlet temperatures may exceed 150°C. However, the short time of process combined with the thermal insulating properties of encapsulants limits exposure to damaging heat (Paini et al., 2015). A study by Tolun et al. (2016) found that combining maltodextrin and gum arabic synergistically enhances encapsulation efficiency and bioactive compound protection. This combination also increased antioxidant activity, with maltodextrin-gum arabic microcapsules showing higher DPPH radical inhibition compared to individual agents (Pierucci et al., 2017). Therefore, maltodextrin and gum arabic are chosen as the carrier agents used for their ability to enhance powder properties and protect bioactive compounds. Therefore, this study investigates the effects of different concentrations and combinations of these carrier agents on the physicochemical properties, total phenolic content, and antioxidant activity of spray-dried strawberry kombucha.

1.2 Objective

1. To evaluate and compare the physicochemical properties of strawberry kombucha analogue and black tea kombucha.
2. To compare the physicochemical properties and phenolic content of liquid strawberry kombucha with spray-dried strawberry kombucha.
3. To investigate the effects of carrier agent concentration and carrier agent types on the total phenolic content of spray-dried strawberry kombucha.

1.3 Hypothesis

1. **Null Hypothesis (H_0):** There is no significant difference in the physicochemical properties between strawberry kombucha analogue and black tea kombucha.
2. **Alternative Hypothesis (H_1):** There is a significant difference in the physicochemical properties between strawberry kombucha analogue and black tea kombucha.
3. **Null Hypothesis (H_0)**: There are no significant differences in using different amounts of carrier agents towards the physicochemical and phenolic content of spray-dried kombucha.

   Alternative Hypothesis (H_1): There are significant differences in using different amounts of carrier agents towards the physicochemical and phenolic content of spray-dried kombucha.
4. **Null Hypothesis (H_0)**: There are no significant differences in using different ratios of carrier agents towards the physicochemical and phenolic content of spray-dried kombucha.

   Alternative Hypothesis (H_1): Different ratios of carrier agents significantly affect the physicochemical and phenolic content of spray-dried kombucha.