Chapter 1

Introduction

1.1 Background

Triphasia trifolia, also known as limeberry, belongs to the *Rutaceae* family and is native to Southeast Asia (Woodson et al., 1979). This plant contains various secondary metabolites, including flavonoids known for their strong antioxidant properties (Tumilaar et al., 2024), and is traditionally used to treat digestive issues and soothe coughs, sore throats, and inflammation (Herdiana et al., 2024). Older generations traditionally consumed the leaves as an anti-inflammatory beverage. In several traditional customs, the leaves and other parts of the plant are infused in hot water and consumed as a herbal drink to obtain the health benefits, commonly referred to as ethnobotanical infusions (Long et al., 2023).

This traditional method is quite similar to preparing herbal tea, which involves infusing plants in hot water. However, modern consumers tend to prefer a simpler, more convenient form, such as herbal tea. Herbal tea is a beverage made by infusing dried plants in hot water and is widely consumed for its bioactive compounds. It is considered a promising alternative to traditional beverages due to its well-accepted form, potential health benefits, and natural antioxidant content. According to Chandrasekara & Shahidi (2018), herbal teas are rich in natural bioactive compounds that could improve antioxidant status and enhance overall health for consumers. Minimal processing has been shown to preserve thermally stable antioxidants, such as flavonoids and phenolic compounds (Long et al., 2024). Herbal tea production often involves harvesting, pre-treatments, drying, and infusion. In tea production, young shoots are commonly used due to their higher concentrations of secondary metabolites, which could significantly affect the tea quality (Zeng et al., 2019).

Tea processing often utilizes oxidation, commonly referred to as 'fermentation', which breaks the cell wall and leads to oxidation. This process releases enzymes and chemical compounds, thus further developing the tea color, aroma, and flavor (Rashwan et al., 2025). Furthermore, pu'erh treatments include spontaneous microbial fermentation, in which the plants are steamed and incubated for several days to allow microbial activity (Pei et al., 2025). Other treatments include direct pan-frying and steaming to prevent chemical reactions in the plants (Adhikary et al., 2023). Direct heat would degrade polyphenol oxidase (PPO), thereby preventing fermentation.

Aside from tea treatments, the brewing temperature plays an important role. Several studies have found that temperature affects the extraction of bioactive compounds present in tea. This would directly affect other parameters such as sensory acceptability and health properties (Cao et al., 2021). Several studies report that the optimal temperature for extracting antioxidants from tea leaves ranges from 60 °C to 100 °C, depending on the type of tea. Given that limeberry leaves contain various bioactive compounds and are known for their anti-inflammatory properties, no studies have examined how treatment and brewing temperature affect the antioxidant and sensory profiles of limeberry leaves.

One of the main problems in herbal tea development is the presence of undesirable attributes, such as grassy and earthy notes, which may reduce consumer acceptance. A study by Wu et al. (2022) found that certain off-notes may significantly reduce overall acceptance of a product, highlighting the importance of appropriate processing and preparation methods. However, treatments and brewing conditions may affect physicochemical properties of the tea. Where treatments and temperature may impact both sensory and functional properties of the final product. Therefore, this study focuses on producing limeberry young shoots as tea, processing them with different treatments and drying methods, and evaluating the effect of brewing temperature on their antioxidant activities, physicochemical properties, and sensory profile. This study aims to investigate the effect of treatment

and the brewing process on the physicochemical and sensory properties of limeberry (*T. trifolia*) shoot tea.

1.2 Objective

The objective of this study is to investigate the effects of pretreatment processes on the antioxidant, physicochemical, and sensorial properties of limeberry (*T. trifolia*) shoot tea. Moreover, to determine the brewing temperature that maximizes antioxidant extraction, physicochemical properties, and the sensorial properties of limeberry (*T. trifolia*) shoot tea.

1.3 Hypothesis

1.3.1 Treatment Process on Antioxidant, Physicochemical, and Sensory Properties

$H0_1$: The treatment process has no significant effect on the antioxidant activity, physicochemical, and sensorial properties of limeberry shoot tea

$H1_1$: The treatment process has a significant effect on the antioxidant activity, physicochemical, and sensorial properties of limeberry shoot tea

1.3.2 Brewing Temperature Effect on Antioxidant, Physicochemical, and Sensory Properties

$H0_2$: Different brewing temperatures have no significant effect on the antioxidant activity, physicochemical, and sensorial properties of limeberry shoot tea

$H1_2$: Different brewing temperatures have a significant effect on the antioxidant activity, physicochemical, and sensorial properties of limeberry shoot tea