USE OF QUALITY ANALYSIS AND CRITICAL CONTROL POINTS (QACCPs) IN VALUE CHAIN DEVELOPMENT FOR BHUTAN ORGANIC BLACK TEA

การใช้การวิเคราะห์คุณภาพและจุดควบคุมวิกฤติ (QACCPs)
ในการพัฒนาห่วงโซ่คุณค่าสำหรับชาดำออร์แกนิกภูฏาน

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ABSTRACT

This research focused on the use of Quality Analysis and Critical Control Points (QACCP) to enhance the value chain development of Bhutan's organic black tea. Although Bhutan aimed to achieve to become 100% organic nation, however they faced several challenges such as inconsistent quality, lack of modern equipment, limited access to organic certification, and weak market. The study explored identifying these issues and developing QACCP–based approach to improve quality, productivity, and competitiveness. The study compared the existing practices and key areas for improvement in Bhutan and Thailand using literature review, field observations, and interviews. The findings from this study showed that QACCP can serve as a practical tool for Bhutanese tea producers to improve each stage of production, while supporting organic standards and sustainability. The redesigned value chain highlighted the importance of proper training, technical support, and cooperative development. This research contributed to academic knowledge, offers practical solutions for farmers and cooperatives to promote Bhutan's organic tea industry in both local and global markets.

Keywords : QACCP, Organic Black Tea, Value Chain Development, Bhutan Agriculture, Quality Assurance

หัวข้อวิทยานิพนธ์ : การใช้การวิเคราะห์คุณภาพและจุดควบคุมวิกฤติ (QACCPs) ในการพัฒนาห่วงโซ่คุณค่าสำหรับชาดำออร์แกนิกภูฏาน

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บทคัดย่อ

งานวิจัยนี้มุ่งเน้นไปที่การใช้การวิเคราะห์คุณภาพและจุดควบคุมวิกฤต (QACCP) เพื่อส่งเสริมการพัฒนาห่วงโซ่คุณค่าของชาดำออร์แกนิกของภูฏาน แม้ว่าภูฏานตั้งเป้าที่จะบรรลุเป้าหมายในการเป็นประเทศออร์แกนิก 100 % อย่างไรก็ตาม ประเทศเหล่านี้เผชิญกับความท้าทายหลายประการ เช่น คุณภาพที่ไม่สอดคล้องกัน การขาดอุปกรณ์ที่ทันสมัย การเข้าถึงใบรับรองออร์แกนิกอย่างจำกัด และตลาดที่อ่อนแอ การศึกษานี้เป็นการสำรวจการระบุปัญหาเหล่านี้และพัฒนาแนวทางที่ยึดหลัก QACCP เพื่อปรับปรุงคุณภาพ ผลผลิต และความสามารถในการแข่งขัน การศึกษาเปรียบเทียบแนวทางปฏิบัติที่มีอยู่ และประเด็นสำคัญสำหรับการปรับปรุงในภูฏานและประเทศไทย โดยใช้การทบทวนวรรณกรรม การสังเกตภาคสนาม และการสัมภาษณ์ ข้อค้นพบจากการศึกษาครั้งนี้แสดงให้เห็นว่า QACCP สามารถใช้เป็นเครื่องมือในทางปฏิบัติสำหรับผู้ผลิตชาภูฏาน ในการปรับปรุงขั้นตอนการผลิตแต่ละขั้นตอน ขณะเดียวกันก็สนับสนุนมาตรฐานออร์แกนิกและความยั่งยืน ห่วงโซ่คุณค่าที่ออกแบบใหม่เน้นย้ำถึงความสำคัญของการฝึกอบรมที่เหมาะสม การสนับสนุนทางเทคนิค และการพัฒนาความร่วมมือ งานวิจัยนี้มีส่วนให้ความรู้ทางวิชาการ นำเสนอแนวทางปฏิบัติสำหรับเกษตรกรและสหกรณ์ เพื่อส่งเสริมอุตสาหกรรมชาออร์แกนิกของภูฏานทั้งในตลาดท้องถิ่นและระดับโลก

คำสำคัญ : QACCP, ชาดำออร์แกนิก, การพัฒนาห่วงโซ่คุณค่า, เกษตรกรรมของภูฏาน, การประกันคุณภาพ

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CHAPTER 1

INTRODUCTION

Background and Rationale

Bhutan, a small landlocked country located in the Eastern Himalayas, is renowned for its unique philosophy of Gross National Happiness (GNH), which prioritizes well–being over material wealth. The nation is celebrated for its rich cultural heritage, characterized by remarkable architectural designs, vibrant festivals, and a distinct cultural identity. Additionally, Bhutan is one of the few carbon–negative countries in the world, as the government emphasizes the conservation of the environment and biodiversity (Srinivasan, 2025; Tzung, 2022).

Tea holds a significant place in Bhutanese culture, extending beyond mere consumption. Apart from serving as a beverage, it is also a symbol of hospitality, tradition, and community. It embodies cultural values and practices that have been passed down through generations. The traditional Bhutanese tea, known as "Suja", is a salted butter tea made from yak or cow butter, salt, and brick tea leaves. In addition to Suja, Bhutan also produces a variety of other teas, including green tea, black tea, white tea, herbal tea, and high–value teas. The preparation of Suja involves churning tea leaves with salt and butter, resulting in a savory and hearty beverage.

The Samcholing Tea Estate, located in the Samdrup Jongkhar district, is Bhutan's first commercial tea plantation, established to reduce dependence on imported tea from neighboring countries. This estate holds cultural significance and embodies a longstanding tradition while demonstrating Bhutan's willingness to innovate in response to changing times while remaining rooted in its heritage.

In Bhutan, serving tea is an integral part of hospitality, often featured in household gatherings, religious ceremonies, and community events. Green tea is appreciated for its distinctive flavors, which are attributed to the country's altitude, climate, and soil conditions. Beyond its palatable qualities, tea is recognized for its numerous health benefits, including its high antioxidant content and positive effects on overall well–being (Klasek Tea Darjeeling et al., 2024; Taste of Bhutan, 2021; Vedika, 2023).

Bhutan's rich biodiversity enables its inhabitants to utilize local herbs and plants to create herbal teas infused with ingredients such as mint or ginger, resulting in beverages that are not only fragrant and flavorful but also imbued with medicinal benefits and therapeutic properties. These herbal teas are renowned for their healing qualities and are employed for various medicinal purposes, reflecting the country's holistic approach to well–being. Additionally, Bhutan offers high–value teas, notably Matsutake tea and Cordyceps tea.

Matsutake tea, derived from the pine mushroom, is 100% organic and wild, boasting numerous health benefits. This tea exhibits immune–modulating properties and is characterized by its distinctive spicy aroma and flavor (Parveen., et al., 2023). The Matsutake mushroom is rich in essential nutrients, including proteins, vitamins A, B6, C, thiamine, niacin, and riboflavin, as well as minerals such as potassium, sodium, iron, copper, calcium, and phosphorus (Fernando, 2024). The potassium content in Matsutake supports healthy heart function and helps maintain fluid balance in the body (Taste of Bhutan, 2024). Its health–promoting attributes, combined with the absence of cholesterol and minimal fat content, contribute to its reputation as a beneficial beverage that may aid in cancer prevention (Foraged, 2023). The Matsutake tea product available under the "Taste of Bhutan" brand comprises 91% green tea, 5% Matsutake, and 4% saffron.

Codyceps tea is another popular high–value tea found in Bhutan. This unique and valuable caterpillar fungus is endemic to the high–altitude alpine regions of the country and highly sought after for its exceptional health benefits. Traditionally utilized in medicine, Cordyceps is renowned for its numerous advantages, including immunomodulatory effects, enhanced energy and stamina, improved respiratory and lung function, anti–inflammatory properties, antioxidant effects, adaptogenic qualities,

and blood sugar regulation (Institute of Medicine, 2003; Santeramo, et al., 2021; Jia, 2024). The life cycle of Cordyceps involves the fungus infecting its host insect during the winter, which is then replaced by a fungal stalk during the summer.

Figure 1.1 The High–value Tea Products of Bhutan: (a) Matsutake Tea and (b) Cordyceps Tea

Source: Druk Herbal Cordyceps Company, 2022; One Gewog One Product of Bhutan, 2024

Organic black tea is one of the most significant agricultural products in Bhutan, given its importance to both the economy and the culture, particularly in regions where agriculture is fundamental to community livelihoods. In recent years, the market demand for organic products, including black tea, has surged, driven by consumer preferences for healthy and environmentally sustainable options (Black Mountain Green Tea, 2024). This rising trend presents numerous opportunities for the market, fostering competition and compelling producers to develop high–quality products that adhere to stringent organic standards.

Bhutan aims to become the world's first fully organic nation, positioning itself as a leader in organic farming practices. The tea industry, still in its developmental stages, plays a crucial role in this vision. When produced in accordance with strict organic standards, organic black tea can significantly contribute to the country's economic development. However, while organic black tea can support this national ambition and offer substantial environmental benefits, producers face challenges in maintaining maximum quality and consistent production within a competitive market

landscape. As numerous producers enter the market with a variety of attractive products, the pressure to meet quality and production standards intensifies.

Problem of Statements

Farmers in Bhutan face significant challenges in consistently maintaining the quality of black tea. A lack of machinery and technology essential for each stage of tea processing—such as withering, rolling, and drying—can lead to lower productivity and inconsistent quality. Additionally, obtaining organic certification presents a considerable challenge, particularly for smaller producers, as the process is often lengthy and costly, involving stringent requirements for organic labeling.

Other notable pain points include inadequate infrastructure, high production costs, limited market access, price fluctuations, shifts in consumer preferences, competition with non–organic producers, and gaps in knowledge and training. Specifically, the challenges stem from limited technical expertise in Quality Analysis and Critical Control Points (QACCP), restricted access to modern equipment, and difficulties in training personnel. Furthermore, Bhutan's mountainous terrain poses logistical challenges that hinder efficient tea production and transportation.

Addressing these pain points is imperative; however, the critical issue lies in identifying effective solutions. A comprehensive approach that combines technological advancements, improved market access, sustainable farming practices, supportive policies, and the implementation of a robust quality assurance system, such as QACCP, is essential to overcome these challenges and ensure the good quality at every stage of the production process.

Research Objectives

Main Objective

The primary objective of this research is to enhance the value chain and the productivity of Bhutan organic black tea by use of Quality Analysis and Critical Control Points (QACCP) program.

Specific Objectives

The specific objectives of this research are as follows:

1. To analyze and design the value chain of Bhutan black tea. This objective aims to study the current value chain for Bhutan organic black tea, identify key factors

for improvement, and propose a redesigned value chain that enhances value creation and competitiveness.

2. To develop a QACCP program for black tea production. This objective focuses on addressing the pain points and challenges faced by black tea producers, aiming to create a systematic approach to quality assurance.

Expected Results

This study is expected for several results:

Contribution to the Organic Tea Industry

This research will provide a framework for quality assurance and value chain optimization for black tea producers in Bhutan. The implementation of the QACCP program and the redesign of the value chain will help address the challenges faced by producers, positioning them as competitive players in the global market.

Broader Implications for Sustainable Agriculture

The findings of this research have the potential to promote sustainable practices within the context of organic farming. The implementation of QACCP in organic black tea production can serve as a model for other organic crops, contributing to the global movement towards more sustainable, green, and environmentally friendly agricultural practices.

Academic Contribution

The QACCP manual developed at the conclusion of this research will contain valuable knowledge on quality assurance and value addition, serving as a guide for current and future agricultural practitioners in Bhutan and beyond. The results of this study will also serve as a reference for future research in related fields.

Research Hypotheses

Introducing a QACCP system in Bhutan will help improve the quality and productivity of organic black tea increasing the competitiveness in the global market. The system will assist in addressing key pain points which will probably result in significant improvements in quality assurance and value addition for tea production.

Redesigning and implementation of a value chain for Bhutan organic black tea will enhance the efficiency of production processes, good quality, reduce waste and increase sustainability within the organic tea processing.

Research Scope and Limitations

Research Scope

The scope of this research encompasses the development of a QACCP program and the redesign of the value chain for organic black tea production in Bhutan. The study will involve on–site research in Thailand and Bhutan, with data collected through online interviews with tea producers and industrial tea experts.

Limitations

One primary limitation of this study is the reliance on online interviews for data collection in Bhutan, which may restrict the depth and comprehensiveness of the information obtained compared to face–to–face interactions. Additionally, the study focuses on specific regions in Bhutan and Thailand, which may limit the generalizability of the findings to other tea–producing regions. Finally, the successful implementation of the QACCP system and value chain redesign will depend on the mutual understanding and cooperation of local stakeholders and producers, as their willingness to adopt the proposed changes is crucial for the success of these initiatives.

Definition of Terms

In this full proposal, there are six key terms defined as follows:

Black Tea

Black tea is one of the widely consumed beverages in the world and it is derived from the *Camelia sinensis var. assamica* plant. It has its own distinct colour, flavor, and characteristics which typically comes from the process known as full oxidation, in which the tea leaves are exposed to oxygen, which undergoes lots of enzymatic reaction leading to browning. This oxidation is the reason black tea is darker in colour, and richer, more robust taste compared to other tea like green tea or white tea, which are not fully oxidized (National Cancer Institute, 2022).

Black tea has been there for generation, and it's considered to be valuable in tradition and culture, and it is because of its caffeine content, antioxidants (like

theaflavins and thearubigins), and countless health benefits like heart health and digestive support (De & Ray, 2022). The process of the production depends on the region, soil, and climate.

Tea Safety and Quality

Tea safety and quality is one of the important things to be concern of in tea production to make sure that the tea is safe for consumption and meets the quality standards. This concerns factors like pesticide residues, microbial contamination, heavy metals, and mycotoxins which will cause immense harm in consumers health if it is present at unsafe levels. There are established safety standards set by international organizations like the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) and adhering to those standards helps to mitigate these risks (Altomonte, 2024).

Black tea quality is assessed by characteristics such as flavour, aroma, colour, and texture and it is influenced by factors like soil quality, climate, and production methods. There are so many systems to enhance quality control throughout the production chain other than QACCP like Good Agricultural Practices (GAP) and Good Manufacturing Practices (GMP) (Chen et al., 2021). These systems if incorporated as said will ensure safety and good quality while reducing the risk of contamination.

Standard Operating Procedure

A Standard Operating Procedure (SOP) is a set of detailed instructions which include a step–by–step process which help workers to carry out routine operations consistently and effectively. SOPs are very important especially in context to black tea production to maintain quality, safety, and efficiency across each production process. They make sure that every step in black tea processing– such as harvesting, withering, rolling, oxidation, drying, and packaging– follows a standardized protocol, reducing potential errors and variability (Alveus, 2024).

SOPs are valuable in managing and providing quality and safety. They provide detailed guidelines on cleanliness, equipment, handling, and safe pesticide use, and often include specific criteria for quality control checks at each stage. Implementation of SOPs carefully can reduce risks of contamination, ensure compliance with industry regulations, and uphold a consistent product quality that meets consumer expectations and legal standards (Encyclopaedical Britannica, 2024).

Hazard Analysis and Critical Control Points (HACCP)

HACCP is one of the tools for food safety and quality which is structurally maintained and preventive food safety system that identifies, assesses, and controls potential possible hazards– biological, chemical, and physical– at various stages of the food production process. It was originally developed by NASA and the Pillsbury Company in the 1960s to ensure food safety.

HACCP is widely implemented in the food industry to prevent hazards before they occur, rather than relying on end–product testing alone. It operated through seven key principles: conducting a hazard analysis, determining critical control points, establishing critical limits, setting up monitoring procedures, defining corrective actions, implementing verification processes, and maintaining detailed documentation (HACCP International, 2020). HACCP helps ensure food safety and compliance with regulatory standards by focusing on critical points where hazards can be effectively controlled.

Quality Analysis and Critical Control Points (QACCP)

QACCP is a comprehensive management system used in food safety and quality control that uses the concept of both the principles of Quality Assurance (QA) with the critical control points of HACCP. QACCP is structured to make sure both the safety and the quality of food products through the identification of key points in the production process where quality could be compromised.

It incorporates preventive measures, such as monitoring, corrective actions, and verification, with a focus on quality criteria like taste, texture, and appearance, in addition to safety hazards (ERA–LEARN, 2024). This system is widely adopted and used in food manufacturing to guarantee that the final product meets both regulatory standards and consumer expectations, combining the operational strengths of HACCP with quality assurance practices (University of Helsinki, 2024).

Supply Chain

A supply chain is a network of series of things such as organizations, resources, activities, and technologies which is involved in the creation and distribution of goods and services to the consumers in the market. It includes everything starting from the procurement of raw materials to the final delivery of finished products to

consumers. The main components of a supply chain are suppliers, manufacturers, distributors, retailers, and customers.

The objective of an effective established supply chain is to optimize processes in every stage, reduce costs, and ensure timely delivery while also maintaining high standards of quality (Weebly, 2024). Modern supply chains are often characterized by global sourcing, just–in–time inventory management, and the integration of information systems that improve communication and coordination across each different stages of production and delivery (Hettiachchige & Rathnayake, 2022).

Value Chain

A value chain is the series of activities that any kind of businesses or organizations perform to deliver a product or service from conception through production to final delivery and beyond. These activities are typically further classified into primary and support activities. Primary activities include–inbound logistics, operations, outbound logistics, marketing and sales, and service. Support activities, such as procurement, development of technology, managing human resource, and infrastructure, guiding the primary activities in adding value to the final product or service. The main goal of a value chain is to maximize and improvise the value creation while reducing costs, ensuring competitive advantage, and responding to customer needs efficiently (Hettiarachchige & Rathnayake, 2021). Analyzing the value chain helps organizations identify areas where they can add value, improve performance, or reduce costs, thereby improving their overall competitive position in the market (Department of Agriculture, Forestry and Fisheries, Republic of South Africa., 2013).

Conceptual Framework

The findings of this study contribute to the advancement of sustainable process development strategies in the organic tea industry, offering valuable insights for policymakers, practitioners, and researchers involved in the promotion of organic agriculture and sustainable food systems.

The proposed conceptual framework for QACCP in the sustainable development of organic tea products in Bhutan encompasses a comprehensive approach integrating quality standards, environmental sustainability, cultural considerations, and economic viability.

Beginning with an elucidation of the QACCP framework, it delineates the current state of organic tea production in Bhutan, highlighting existing challenges and limitations. Through meticulous analysis, critical control points (CCPs) are identified across the production process, spanning cultivation, harvesting, processing, and packaging. Quality parameters and standards, inclusive of both international benchmarks and local preferences, are established, alongside environmental sustainability measures that mitigate impacts on soil, water, biodiversity, and carbon footprint.

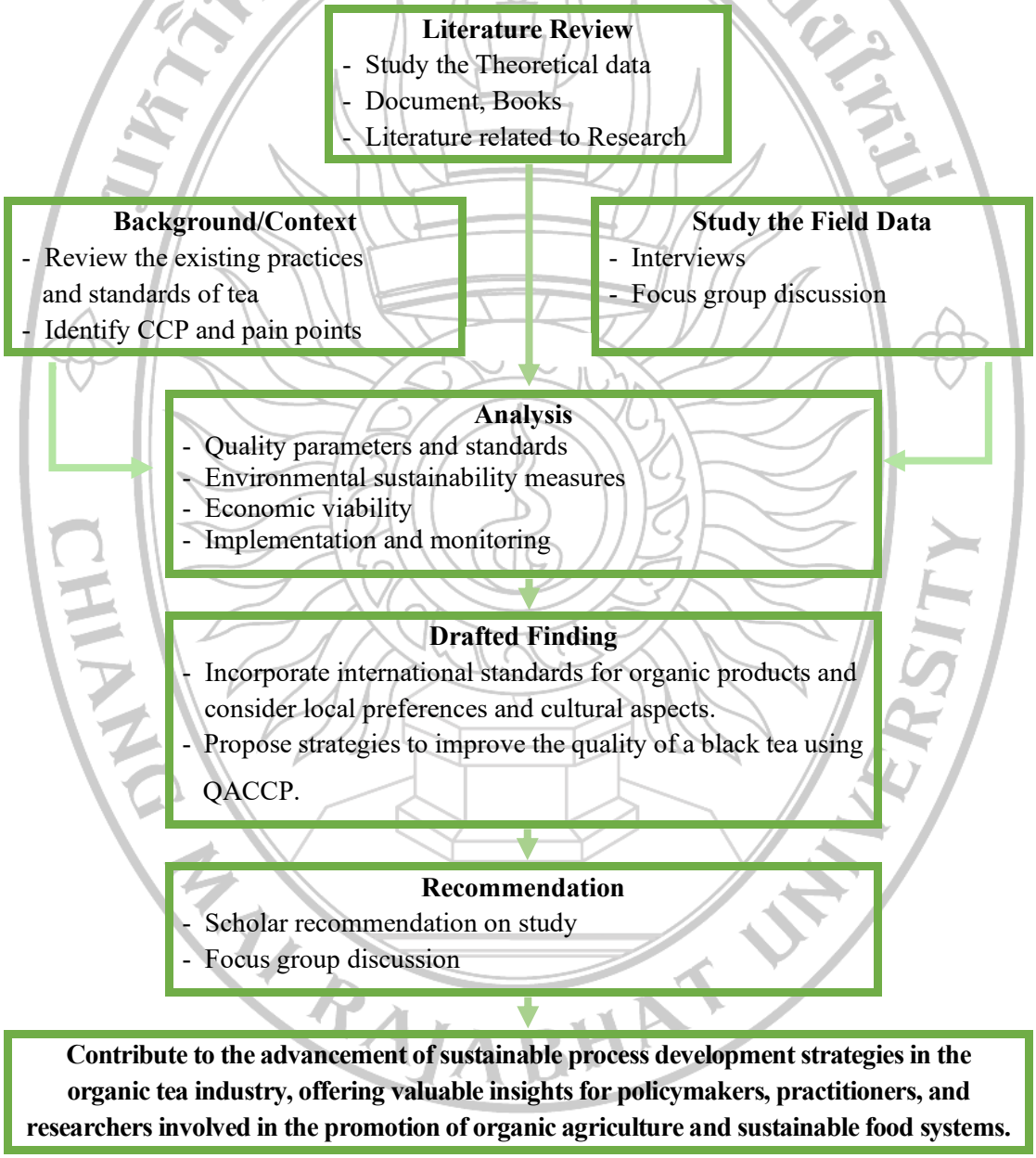
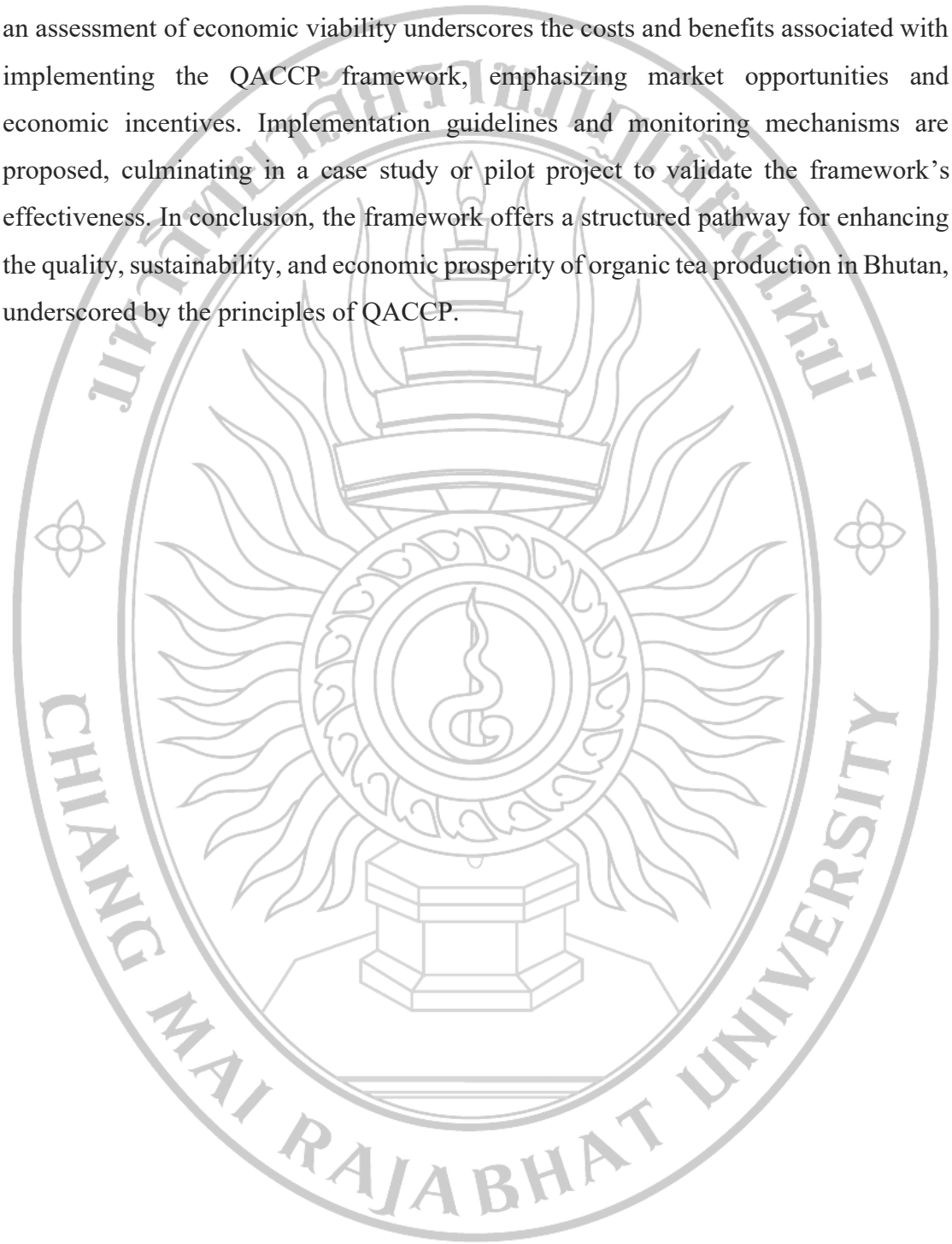


Figure 1.2 Conceptual Framework

Acknowledging the cultural significance of tea production in Bhutan, the framework integrates traditional knowledge and practices, ensuring alignment with local customs while upholding quality and safety standards. Furthermore, an assessment of economic viability underscores the costs and benefits associated with implementing the QACCP framework, emphasizing market opportunities and economic incentives. Implementation guidelines and monitoring mechanisms are proposed, culminating in a case study or pilot project to validate the framework's effectiveness. In conclusion, the framework offers a structured pathway for enhancing the quality, sustainability, and economic prosperity of organic tea production in Bhutan, underscored by the principles of QACCP.



CHAPTER 2

LITERATURE REVIEW

Organic Black Tea

The organic black tea production in Thailand and Bhutan

Organic black tea is one of the most significant agricultural products in Bhutan, valued for its economic and cultural importance, particularly in regions like Bhutan and Thailand, where agriculture plays a crucial role in sustaining communities. In recent years, the market demand for organic products, including black tea, has surged, driven by consumer preferences for healthy and environmentally sustainable options (FAO, 2022). This rising trend presents numerous operates for market competition, challenging producers to create attractive, high–quality products that adhere to stringent organic standards.

Bhutan is committed to organic farming, with the ambitious goal of becoming the world's first fully organic nation. The tea industry, still in its developmental stages, plays a vital role in this vision. When produced in compliance with strict organic standards, organic black tea can significantly contribute to the country's economic development. However, while organic black tea supports this national ambition and offers substantial environmental benefits, producers often face challenges in maintaining high quality and consistent production in a competitive market, especially when many other producers offer diverse and appealing products.

In Thailand, regions such as Chiang Mai and Chiang Rai are renowned for their tea production, including organic black tea. The favorable climatic conditions and the country's agricultural heritage provide an ideal environment for tea cultivation. Like Bhutan, Thai tea producers encounter challenges in upholding high–quality standards while ensuring adherence to organic farming practices.

Health Benefits of Black Tea

Black tea (*Camellia sinensis*) is one of the most widely consumed beverages globally, celebrated for its unique flavour, rich history, and numerous health benefits. Characterized by fully oxidized leaves, black tea boasts a dark colour and robust flavour profile. Its popularity has surged as consumers increasingly seek health–conscious alternatives.

Originating in China, black tea has gained worldwide acclaim. The health benefits of black tea are attributed to its bioactive compounds, particularly polyphenols, which exhibit strong antioxidant properties. These compounds help combat oxidative stress and may reduce the risk of chronic diseases, including cancer and cardiovascular issues. Research indicates that regular consumption of black tea can lower blood pressure and improve lipid profiles, contributing to better heart health (Davies et al., 2003; Greyling et al., 2014). Specifically, drinking three or more cups per day is associated with a reduced risk of cardiovascular events.

Additionally, black tea may assist in weight management by enhancing metabolic rate and fat oxidation, largely due to lipid–metabolizing polyphenols such as thearubigins (Zhao et al., 2019; Zhao, & Li et al., 2018). Daily consumption of black tea has also been linked to improved cognitive function, as the caffeine and L–theanine content may enhance alertness and cognitive performance, potentially lowering the risk of neurodegenerative diseases (Khan & Mukhtar, 2023; García–López et al., 2023).

In Bhutan, the production of organic black tea is gaining significant recognition, driven by the country's pristine natural environment and commitment to sustainable practices. Organic farming methods, which eschew synthetic fertilizers and pesticides, help preserve the ecological balance of the region. As a result, organic black tea holds substantial potential in a market characterized by immense growth opportunities.

Black Tea Processing

The production of black tea involves several steps, with four main stages: withering, rolling, oxidation, and drying (Alveus, 2024; Encyclopedia Britannica, 2024; TeaVivre, 2024; Young Mountain Tea, 2024) as seen in Figure 2.1

The initial stage, withering, involves spreading freshly harvested leaves in a controlled environment. This step aims to reduce the moisture content from approximately 80% to 60%, making the leaves suitable for the subsequent rolling process. The duration of withering typically ranges from 12 to 16 hours, depending on environmental conditions and the desired characteristics of the tea.

Next is the rolling process, where the leaves are mechanically twisted and bruised to break down the cell structure and initiate oxidation. This step influences the shape of the leaves and is crucial for flavour development. Different rolling techniques, such as hand–rolling and machine rolling, can affect the final quality of the product.

Oxidation is a key factor that distinguishes black tea from green tea. The bruised leaves are spread out in a temperature–controlled environment, allowing enzymatic reactions to occur. This stage can last from 30 minutes to several hours, depending on the desired flavour profile. During oxidation, catechins are transformed into theaflavins and thearubigins, which contribute to the colour and taste of black tea.

The final stage is drying the oxidized leaves, which halts the oxidation process and reduces moisture content to around 3%. This can be achieved using hot air or pan–frying methods. Proper drying is essential for preserving flavour and preventing spoilage

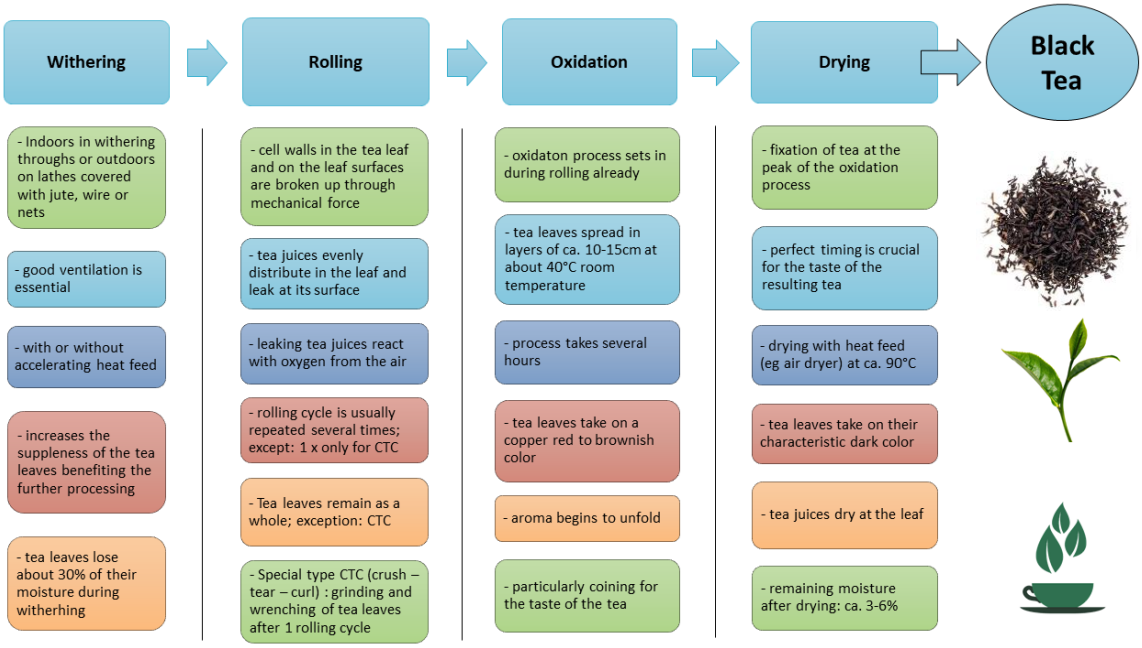


Figure 2.1 Flow chart of black tea processing

Source: SiamTee Thomas Kasper Tea Import & Distribution, Germany, 2024

Several research reports have presented the development of quality in black tea throughout the production chain, from production factors to the preservation of product quality. The control and establishment of quality systems in black tea production rely on various scientific techniques and standard operation procedures (SOPs), as shown in Table 2.1.

Table 2.1 Summarize the development of black tea quality using SOPs from the referenced publications

Quality factor	SOP	Quality Improvement	Reference
1. Tea harvesting	– Fine plucking removes a bud and two leaves. – Short term plucking.	– Produced significant amounts of total flavonoids, optimal levels of polyphenol oxidase activity and catechin concentration – Short plucking intervals were preferable than long rounds in terms of caffeine, total flavonoids, brightness, aroma, and sensory ratings	Exotic Teapot (2023)
2. Harvesting Season	– Harvested in spring season – Thailand and Bhutan no have spring season	– Less bitter and astringent (caffeine, catechin, epicatechin, epicatechin gallate, total polyphenols) – More umami (glutamic acid, total amino acids) – Darker infusion colour (theaflavins, theabrownins) – Higher taste quality	Aaqil et al. (2023)
3. Re–Rolling treatment in the oxidation process	– 1 h rolling, 2.5 h oxidation, 0.5 h rolling and 2 h oxidation	– A floral/fruity aroma, good taste, and without a green/grassy odor – Simultaneously using small– and medium–leaf tea species	Chen et al. (2023)
4. Oxidation conditions	– General oxidation (20–30 ºC for 30–120 min), optimum (25 ºC for 60 min)	– Increased total flavonoids formation, astringent, brisk, bright, favors dark–colored thicker black tea.	Aaqil et al. (2023)

Table 2.1 (Cont.)

Quality factor	SOP	Quality Improvement	Reference
5. Sun withering degree	– Temperature 20–32 ºC. light intensity 25,000 lux in April–May. The freshly picked tea leaves were mixed and spread flatly on 6 bamboo sieves of about 1 m in diameter, with the leaves thickness of about 3.5 to 4 cm. The harvested leaves (75% water content) were first exposed to the sun for outdoor withering to 66–69% followed by indoor withering to 60% water content.	– Freshness, sweeter taste, and a sweet and even floral and fruity aroma	Wu et al. (2023)
6. Drying	– Dry black tea at 110 ??C for 10 min, followed by 85 ??C for 3.5 h at 1.5 rpm dryer speed.	– Results in high–quality tea. – Sustain the tea's moisture content.	Aaqil et al. (2023)
7. Storage method and duration	– Stored the black tea in normal optimum conditions over control.	– Give bright colour, increased caffeine content.	Hong (2021)

Quality Analysis and Critical Control Points (QACCP)

The QACCP system is a comprehensive approach to managing and improving product quality throughout the production process. The term QACCP is derived from the HACCP framework; the main difference is that QACCP expands beyond food safety by identifying biological, chemical, and physical hazards. This encompasses broader aspects of product quality that include consistency, sensory characteristics (such as flavour, texture, and appearance), nutritional value, and adherence to organic certification standards (CORE Organic, 2024; ERA–LEARN, 2024; Jha, 2024).

This system involves identifying critical control points at various stages of the food production process, including cultivation, harvesting, processing, and packaging, particularly in areas where issues are most likely to arise. Addressing these challenges and implementing preventive measures at these points will help producers reduce the risk of quality defects and ensure that food quality meets the requirements of both food safety certifications and consumer expectations. The QACCP system is not just about maintaining product quality; it can also improve productivity by optimizing processes and reducing waste.

The adoption of the QACCP system in organic black tea production in Bhutan has immense potential to significantly enhance both the quality and quantity of the output, enabling producers to compete more effectively in the global market. This approach is particularly valuable in tea industries, where quality attributes are as crucial as safety. Integrating QACCP into food production systems ensures not only safety but also consistency in quality. QACCP will help address specific challenges faced by black tea producers.

Quality Assessment of Black Tea

Quality assessment of black tea encompasses physical, chemical, microbiological, and sensory evaluations as follows:

The first, physical evaluation, includes appearance (uniformity, dark brown to black colour, with minimal dust or broken leaves), texture (leaves should be dry, brittle, and free from foreign substances), and size (consistent leaf size, graded according to type, such as whole leaf or broken leaf).

Chemical analysis focuses on the tea's bioactive compounds, including polyphenols, caffeine, and flavonoids (Zhao et al., 2023; Babu, et al., 2020). Black tea contains significant amounts of theaflavins and thearubigins, which exhibit antioxidant properties. A typical black tea may contain 10–20% polyphenols by weight (Wang et al., 2023; Babu & Liu, 2014). Generally, black tea contains about 40–70 mg of caffeine per 8–ounce serving, contributing to its stimulating effects. Flavonoids offer various health benefits, including promoting cardiovascular health (SAKI Products, 2024; Chaturvedi & Mishra, 2019).

The third aspect, microbiological quality, is crucial for ensuring safety. Black tea should be free from harmful bacteria (such as Salmonella and *Escherichia coli*) and molds. It is vital to mitigate contamination risks, which can be achieved through regular testing and quality control measures.

The final analysis is sensory evaluation, which includes assessing aroma, flavour, and mouthfeel. High–quality black tea should have a complex, pleasant fragrance that can range from floral to malty. The flavour should be rich and balanced, varying by type; Assam tea is bold and malty, while Darjeeling tea is more delicate and floral. In terms of mouthfeel, it should be smooth, with a desirable full–bodied texture and a lingering aftertaste (Brew Your Sip, 2024; Finest Organic Tea, 2024).

The quality of black tea from various countries e.g. India, Pakistan, Sri Lanka, China, and ASEAN countries are primarily referenced according to the ISO 3720:2011 standard (4th edition, 2011). Additionally, there is Thai Community Standards (TCS 120/2015), as shown in Table 2.2.

Table 2.2 The Summary of quality of black tea from various countries

Country	Quality	Standard
Pakistan	– Moisture content	7% max.
India	– Power, mass fraction	2% max.
Kenya	– Water extract, mass fraction	32% min.
China	– Total ash, mass fraction	4.0–8.0%
ASEAN	– Water –soluble ash, mass fraction of total ash	45% max.

Table 2.2 (Cont.)

Country	Quality	Standard
Thailand	– Alkalinity of water – soluble ash (as KOH), mass fraction	1.0–3.0%
	– Acid insoluble ash, mass fraction	1.0% max.
	– Crude fibre, mass fraction	16.5% max.
	– Total polyphenols, mass fraction	9.0% max.
	– Total catechins	7% min.
	– Moisture	8% max.
	– Caffeine	1.5% max.
	– Total Plate Count	1 x10^4 CFU/g
	– Salmonella	Not found/25 g
	– *Staphylococcus aureus*	<10/ 1 g

Organic Certification Bodies in Maintaining Tea Standards

Organic certification bodies such as USDA Organic and EU Organic play a crucial role in maintaining standards in organic tea production. These organizations are responsible for setting and enforcing guidelines that ensure the production process is environmentally sustainable, free of synthetic chemicals, and adheres to ethical practices. Their certification provides credibility to producers and assurance to consumers that the product meets stringent organic standards. Non–compliance can result in penalties or loss of certification.

These bodies establish rigorous criteria for organic production, covering soil quality, pest and weed control, the use of organic seeds, and natural farming practices. For example, USDA Organic requires that crops be grown without synthetic fertilizers or pesticides and emphasizes biodiversity. They also conduct regular audits to ensure compliance with organic standards, which includes field inspections, soil tests, and reviewing records to confirm that all materials used in production meet organic criteria. Certification logos (USDA Organic, EU Organic) serve as a seal of trust for consumers, assuring them that the products adhere to high ethical and environmental standards, thereby boosting demand for organic tea in international markets.

The USDA Organic certification is governed by the National Organic Product (NOP) in the US which deals with organic agriculture and product labeling. The key standards for this certification are on four major terms each for crops, livestock, processed foods, and land management. The crops must be grown in the field free from any harmful chemicals or fertilizers for at least 3 years. Livestock must be fed with only organic fed, allow access to outdoors, and cannot receive antibiotics or growth hormones. At least 95% of processed foods must be organic, no artificial preservatives, colours or flavours. Soil health is maintained by focusing on crop rotation, cover cropping, and organic pest control. USDA organic labeling is divided into three namely 100% Organic, Organic, and Made with Organic Ingredients. To process for organic certification farmers must apply with details of farming practices, inputs used, and production methods. A certified organic inspector will visit the site and verify compliance with organic standards. Then it is followed by review for approval and if approved, the producer receives organic certification valid for one year.

The EU Organic Certification is a strict standard made by the European Union (EU) to ensure that the organic labelled agricultural products meet specific criteria regarding production, processing, and labelling. It guarantees and warn consumer trust that the product they used are organic, environmentally safe, animal welfare standards, and sustainable resource use. The key principles of EU Organic Certification are sustainable practices, natural inputs, animal welfare, no GMOs (Genetically Modifies Organisms), traceability and transparency. The certification process includes application, inspection, certification decisions, and annual inspections. Products must meet certain criteria to get EU logo for an instance the products should be 95% organic and must meet specific production processing requirements. The label must include the EU organic logo, certification code, and indication of the origin of raw materials (e.g., EU Agriculture or Non–EU Agriculture).

Thailand's organic certification system follows the path of international and national standards for organic farming ensuring that the agriculture products are organic. The certification process is overseen by government agencies, private certification bodies, and international organizations. Key organizations include National Bureau of Agricultural Commodity and Food Standards (ACFS), Organic

Agriculture Certification Thailand (ACT), and IFOAM Accreditation. Thailand certification is based on Thai Organic Standard (TOS) which follows the steps of international standards like those of the EU, USDA, and Codex Alimentarius. Their key principles include no use of synthetic inputs, no genetically modified organisms, encourage crop rotation, composting and natural pest control, animal welfare and traceability. The certification process includes several steps like application, inspection, evaluation, certification, and annual inspections. Organic Thailand logo is issued by the Department of Agriculture for certified domestic organic products and products bearing this logo comply with national organic standards.

Globally, organic tea producers adhere to strict quality control protocols to ensure their products meet organic certification standards, including USDA Organic, EU Organic, and other region–specific certifying bodies. Many producers implement HACCP or ISO 22000 food safety management systems to maintain quality. In Bhutan, the tea industry is still developing, with some producers seeking organic certifications to cater to international markets. The challenges and risks involve standardizing practices across the industry to ensure consistent quality and safety.

Quality Management Systems in Organic Tea Production

Implementing a robust quality management system in organic tea production poses several challenges. One significant issue is compliance with multiple standards, as different markets require adherence to various regulations: for instance, the USDA Organic standard for the U.S. and the EU Organic standard for Europe. For producers exporting globally, meeting the diverse requirements of multiple certification bodies can be complex, time–consuming, and expensive. Many small–scale tea farmers often lack the necessary technical knowledge and resources to implement complex organic farming methods. The high costs of organic certification pose a considerable challenge for these small–scale producers, encompassing not only certification fees but also expenses related to organic farming practices, record–keeping, and investment in organic inputs.

Pest and disease management is more challenging as farmers are limited to using only organic fertilizers. Natural methods may not always be as effective, potentially resulting in lower yields or inconsistent quality (ITO EN, 2024).

Furthermore, managing the entire supply chain–from harvesting to processing to packaging–while ensuring adherence to organic standards is difficult. Cross–contamination with non–organic materials during processing or transport can jeopardize certification. Organic tea production is also highly sensitive to environmental changes. Soil degradation, unpredictable weather, and water scarcity can all impact organic tea farms, making it tougher to maintain the consistent quality required for certification.

The production of tea consists of several stages, each affecting the final quality of the product. QACCP can be applied at critical points, from planting and using organic fertilizers to pest management, harvesting, withering, rolling, fermentation, drying, and packaging, ensuring the production of high–quality organic black tea. For example, the withering stage requires precise control to prevent spoilage or loss of flavour, as this is when tea leaves lose moisture. QACCP in this stage would involve monitoring moisture levels and ensuring an optimal environment for withering. Similarly, during fermentation, QACCP can help maintain the desired oxidation level to achieve the perfect balance of flavour and colour in black tea.

The use of QACCP in organic black tea production offers several benefits. It improves consistency in flavour, aroma, and appearance, aligning with consumer expectations for organic products. Additionally, it enhances trust among consumers and stakeholders due to the transparent and traceable nature of the QACCP system, fostering strong relationships between producers and consumers. Moreover, it helps mitigate the risks associated with non–compliance with organic certification standards. In conclusion, QACCP contributes to product consistency, marketability, and sustainability.

Implementing QACCP can be particularly challenging in regions like Bhutan, where infrastructure, technical expertise, and access to resources are limited. While these challenges are significant, they are also solvable with thoughtful, consistent efforts. Effective implementation requires thorough training, investment in modern equipment, and collaboration among stakeholders. Additionally, support from the government and international partnerships is crucial to building capacity and ensuring compliance with QACCP standards.

Quality of Black Tea and Its Factors

The quality of tea is influenced by several factors by a combination of environmental, processing, harvesting, and storage factors.

1. Environmental Factors

Tea needs good growing soil conditions filled with nutrients to give better flavour and aroma. Soil pH levels of 4.5 to 5.5 is optimum for tea cultivation and nitrogen and potassium are one of the crucial minerals for leaf quality. Balanced sunlight for good photosynthesis to take place, ideal temperature between 18 to 30 degrees Celsius and rainfall must be annually and distributed evenly. High altitude gives out the best tea quality with complex aromas due to slower leaf growth. Pest and disease control for good leaf quality.

2. Harvesting Practices

The timing and plucking of tea leaves is another important factor to consider. Fine plucking of two leaves and bud give good yield and quality teas. Different seasons give different quality, for example first flush in the earliest spring leaves are delicate and aromatic while second flush ones are bolder and more flavorful and monsoon teas are lower in quality due to excess moisture.

3. Processing Techniques

Every tea processing step must be handled with consistent care to provide a final good quality. The four main steps include withering, rolling, oxidation /fermentation and drying. Withering is a step which helps to reduce the moisture content and improve the concentration of flavours. Improper withering will produce uneven flavour development. Rolling breaks down the cell walls releasing tea juice and enzymes so under–rolling or over–rolling will affect the oxidation and flavour. Fermentation step will determine tea's colour, flavour and aroma so poor control of this step will lead to inconsistent qualities. The final step of drying helps to remove moisture to prevent spoilage, and over–drying can burn leaves while under–drying risks microbial contamination.

4. Storage Conditions

The storage conditions should be good to maintain the quality after processing. Ideal storage must be airtight containers and dry because high moisture levels will cause mold growth and loss of flavour. The tea must be stored away from

light as it will degrade flavour compounds and deteriorate colour. Tea should be stored in cool places and stable environments because extreme temperature leads to oxidation and spoilage. Product packaging must be good otherwise the poor packaging will allow absorption of external odors and flavours which will compromise tea quality.

5. Chemical Composition

Black tea contains different kinds of chemicals and the concentration depends on variety, climate, and processing. Polyphenols are responsible for tea's astringency and antioxidant properties. Amino acids like theanine contribute to tea's sweetness. Caffeine adds bitterness and stimulates the palate essential oils provide aroma and flavour complexity. Theaflavins and thearubugins are two key compounds which are formed during the oxidation process. Theaflavins are formed when catechins undergo enzymatic reaction during oxidation. It contribute to the briskness, brightness and astringency of black tea. It have antioxidant, anti–inflammatory, and anti–cancer properties. Thearubigins are formed in similar way and responsible for dark color of black tea and rich taste.

6. Human Factors

The tea quality is also contributed by the labours who is doing all the work.The labours must be skilled with knowledge and practice. The workers must be updated with current technology and expertise. Traditional combined with technology and organic practices with sustainable goals have an impact on tea characteristics.

A Value Chain

The value chain is a concept introduced by Michael Porter in his 1985 book "Competitive Advantage". (Cambridge Institute for Sustainability Leadership, 2024). It refers to the full range of activities that businesses engage in to bring a product or service from conception to delivery and beyond as shown in Figure 2.2. The idea is to identify ways to create value at each step of the process, thereby gaining a competitive advantage.

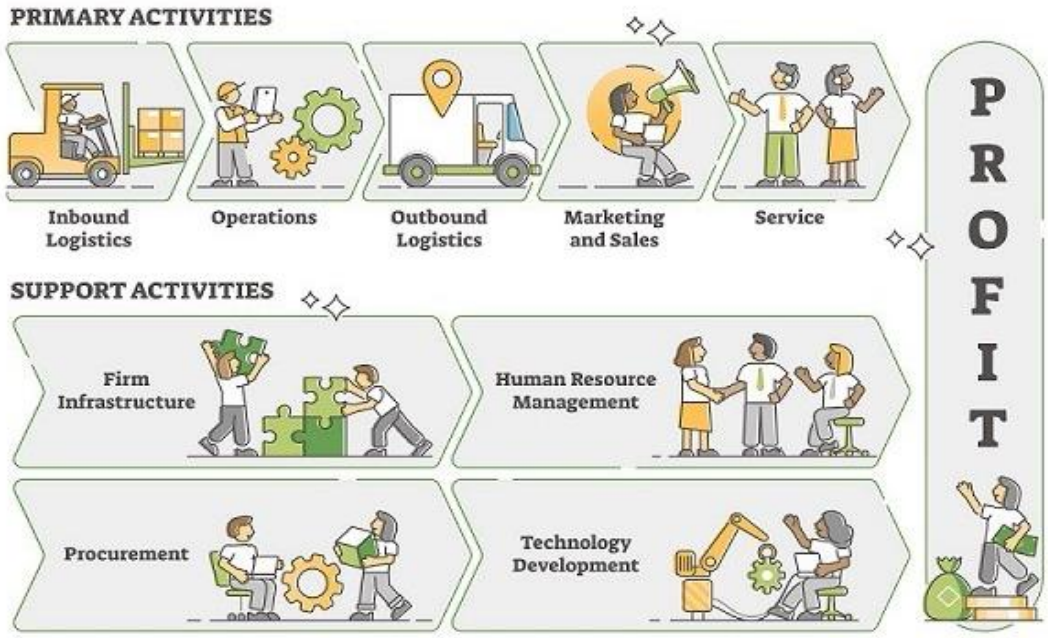


Figure 2.2 Porter's value chain concept

Source: Trade Beyond (2024) adapted from Porter (1985)

The value chain is typically divided into two main categories:

1. Primary activities: These are directly involved in creating and delivering a product or service. They include:

Inbound logistics: Receiving, warehousing, and inventory management of inputs.

Operations: Processes that transform inputs into the final product.

Outbound logistics: Activities required to get the finished product to customers.

Marketing and sales: Strategies and activities that promote and sell the product.

Service: Activities that maintain and enhance the product's value, such as customer support.

2. Support activities: These helps enhance the effectiveness and efficiency of primary activities. They include:

Procurement: Acquiring the goods and services needed for production.

Technology development: Research and development, process automation, and product design.

Human resource management: Recruiting, hiring, training, and developing employees.

Firm infrastructure: Organizational structure, planning, finance, and quality control.

By analyzing the value chain, companies can identify areas for improvement, cost reduction, and differentiation, ultimately leading to increased competitiveness and profitability.

The value chain of Bhutan organic black tea encompasses all the steps involved in producing and delivering the final product to consumers, from initial cultivation to processing, distribution, and marketing. Designing and analyzing this value chain is crucial for understanding how value is created and captured at each stage of the production process. It also helps identify opportunities for improvement, such as enhancing efficiency, reducing costs, and increasing product quality.

For a country like Bhutan, where the tea industry is still developing, a well–structured value chain can play a critical role in establishing the nation's reputation as a producer of high–quality organic black tea. By understanding the value chain, Bhutanese producers can improve their production processes by incorporating best practices that align with market demands, ultimately helping them meet the expectations of international buyers.

3. Cultivation and input supply

The cultivation of organic black tea begins with the careful selection of seeds and organic inputs, such as fertilizers and pest control methods. Organic certification requires that no synthetic chemicals are used at this stage, relying instead on natural fertilizers and biological pest control techniques. Research indicates that sustainable farming practices, including crop rotation, mulching, and the use of organic compost, significantly enhance soil fertility and yield without compromising environmental sustainability (Sharma, Sharma, & Thakur, 2024). While the use of organic inputs may result in lower yields compared to conventional tea farming due to limited pest control and nutrient supply, organic tea can fetch premium prices in the market, potentially offsetting these challenges. Developing a strong network of input

suppliers and providing farmers with access to organic–certified inputs is crucial for maintaining the quality of organic black tea.

4. Production and harvesting

The production stage of organic black tea focuses on maintaining high–quality tea leaves. It emphasizes labour–intensive practices, such as hand plucking of tea leaves, which ensures the selection of young, tender shoots that contribute to the quality of the final product (Exotic Teapot, 2023). Farmers play a significant role in ensuring that the harvesting process adheres to organic standards, as improper handling can lead to contamination. Organic tea farming is labour–intensive and often involves small–scale farmers with limited resources. Challenges such as higher labour costs and increased risk of crop failure necessitate that farmers join cooperatives or producer groups to improve their bargaining power, access shared knowledge, and negotiate better prices (Aaqil et al., 2023).

5. Processing

After harvesting, the tea undergoes several processing stages, including withering, rolling, oxidation, and drying, to develop the characteristic flavour of black tea. Each step of organic black tea processing must adhere to strict guidelines to maintain organic certification. No synthetic additives or preservatives are used in this organic process, and the entire process is carefully monitored to avoid contamination from conventional teas (Aaqil, et al., 2024). Additional value is added during processing, including blending and packaging, where branding and labelling significantly contribute to the tea's marketability. Using biodegradable packaging can further align with the sustainability principles of organic farming.

6. Distribution and Marketing

Cooperatives, exporters, importers, and retailers play significant roles in the distribution of organic black tea. With the growing demand for organic products, market in strategies often emphasize sustainability, ethical farming practices, and health benefits. The premium pricing of organic black tea is linked to consumer perceptions of these attributes (Ellis, et al., 2006). Certifications such as Fair Trade and Rainforest Alliance, along with international trade policies, shape the value chain of organic black tea. These certifications ensure that producers receive a fair price that

covers the costs of sustainable farming while also providing a premium for community development and environmental protection

Challenges and Opportunities of Bhutan Organic Black Tea

Despite the growing demand for organic black tea made in Bhutan, smallholder farmers–who are the backbone of organic tea production–face several challenges. They often struggle to access finance, organic inputs, and certification processes. Additionally, the fragmented nature of the supply chain in many tea–producing regions results in inefficiencies, including inconsistent quality, limited market access, and high transaction costs (Van Tilburg et al., 2011). The limited availability of processing facilities dedicated to organic tea presents another obstacle. Since organic and conventional tea must be processed separately to prevent contamination, the absence of specialized organic processing units can impede the growth of the organic tea sector (Doanh, Thuong, & Heo, 2018). Table 2.2 summarizes the stakeholders involved in black tea production in Bhutan who face challenges throughout the supply chain, and identifies the bottlenecks and inefficiencies that affect productivity, costs, competitiveness in global markets, and the promotion of Bhutanese tea as a premium product.

There are several opportunities to enhance the value chain of organic black tea. Building capacity through training and extension services can help farmers improve their organic farming techniques and adopt sustainable best practices. Furthermore, strengthening cooperatives and farmer organizations can empower smallholder farmers to access better markets and negotiate fair prices. The increasing global demand for organic products offers a promising market for organic black tea. E–commerce and direct–to–consumer models are gaining traction, providing tea producers with a more direct route to consumers, thus bypassing intermediaries and increasing profitability (Gamage et al., 2023). Additionally, the integration of technologies, such as blockchain for supply chain transparency, could help address issues of traceability and certification fraud, further enhancing consumer trust in organic tea product.

The value chain of organic black tea is a complex system involving multiple actors and processes. While challenges such as high certification costs and fragmented

supply chains exist, the rising demand for organic and ethically produced goods presents numerous opportunities for value chain improvements. By fostering collaboration among stakeholders, improving access to organic inputs and markets, and adopting innovative technologies, the productivity and sustainability of the organic black tea industry could be improved

Table 2.3 Summary of bottlenecks and inefficiencies throughout the supply chain of black tea made in Bhutan

Shareholder	Supply Chain	Bottlenecks and Inefficiencies
Farmer	**Inputs:** organic seeds, biofertilizers, water, tools **Cultivation:** hilly regions **Harvesting:** handpicked to ensure premium quality **Challenges:** small–scale farming, high labour costs, limited access to advanced organic farming techniques	– Limited access to organic inputs – High production costs – Labour–intensive harvesting – Lack access to modern organic farming techniques
Processors	**Initial processing:** withering, fermenting. drying and sorting **Packaging:** eco–friendly, moisture–proof to preserve freshness **Challenges:** high cost of organic certification, lack of modern processing infrastructure	– Lacking in modern equipment – High cost of organic certification – Quality control issues – Logistical delays/ transportation or processing facilities are not efficient

Table 2.3 (Cont.)

Shareholder	Supply chain	Bottlenecks and Inefficiencies
Exporter	**Logistics:** shipped to countries in Asia, Europe, and the U.S. **Challenges:** high transportation costs, fluctuating international demand, limited marketing resources	– Transportation challenges – Limited market access – Regulatory barriers
Distributors/Retailers	Domestic Markets International Markets	– Small distribution networks – Lack of promotion
Retailer	Domestic International	– Limited consumer awareness domestically – Price sensitivity to cost–conscious consumers both domestic and international markets

Tea Manufacturers in Chiang Mai, Chiang Rai and Bhutan

"The Samcholing Tea Cooperative" which is also officially called as Samdrupcholing Ngoja Tshonglay Detshen is well known and notable because of only women who works and look after the cooperative. It is in Samcholing village, Drakten gewog within Trongsa district in Bhutan. The cooperative is established in April 2009 with 27 founding members and then the cooperative is expanded and currently have 34 women ranging in age from 20 to 81. Their primary focus is in the cultivation and production of green tea from *Camelia Sinensis var. assamica* plant. The origins of tea cultivation in Samcholing is traced back to early 1950s when Bhutan's second king, His Majesty Jigme Wangchuk, planted tea bushes at the Samdrupcholing palace which

he received as a gift from Sikkim, Darjeeling. In 2011, a group of women formed the Samcholing Tea Cooperative in over 50 acres of land. By 2018, the cooperative achieved organic certification, enhancing the quality and marketability of their tea (Organic Bhutan). They follow both traditional and modern methods in tea processing, emphasizing manual labour and organic farming techniques. The tea are cultivated with no chemical fertilizers ensuring that it is pure organic. The processing of black tea involves hand–plucking, withering, rolling, oxidation, and roasting. They also deal with green tea, oolong tea and suja which is the Bhutanese traditional tea. The cooperative has significantly improved the livelihoods of its members for an instance, a single mother named Sonam reported that she earns approximately Nu 100,000 annually which she can support her daughter's education. The initiative has empowered women in the community, providing financial stability and fostering the sense of responsibility and work ethic among the younger generation (Ugyen C. Penjor, 2024). In 2019, the cooperative received the prestigious Best Green Tea Producers Award from the Government of India. Government has provided the continuous support by providing members with training programs in Nepal, Japan, China, and India. In conclusion, the Samcholing team cooperative is a successful blend of historical legacy, traditional agricultural practices, and community–driven development, contributing to Bhutan's economic and ever–growing reputation in the global tea market.

The Doi Tung Development Project (DTDP) in Chiang Rai was established in 1988 by the Mae Fah Luang Foundation under Royal Patronage, superheaded by the late Princess Mother, Her Royal Highness Princess Srinagarindra. The primary goal was to eradicate opium cultivation in the Golden Triangle region by providing sustainable alternative livelihoods to the local ethnic communities. Before the project start, the area was filled with opium cultivation, deforestation, and poverty among the local hill tribes. The cultivation was started in mid–1990s as a goal to provide alternative livelihoods and restore the environment. The project focused on cultivating high–quality tea varieties suitable for the region's climate and terrain. Through tea cultivation promotion, the DTDP aimed to create a sustainable source of income for local communities, reduce deforestation, and eliminate the dependence of opium farming (United Nations, Sustainable Development). Their cultivation includes two kind of techniques which are organic farming and agroforestry model. The packaging

of the product emphasizes on eco–friendly and market its tea products as premium, ethically produced goods, aligning with the project's sustainable development goals (Siam Teas). The development project has benefits in environment, economy, tourism and education (Saengmanee, 2018).

Raming Tea Estate is in the Mae Taeng District of Chiang Mai province, Thailand and it has a rich history of the tea cultivation traditions. Initially tea was introduced to Mae Taeng by ancient migrations of ethnic groups from Yunnan, Xishuangbanna, and Myanmar in the 13th century. Those people brought the knowledge of tea cultivation, and which begins as the foundation for the area's tea industry. The Wangwiwat family established Raming Tea Estate in the 20th century, and they become pioneers in cultivating and producing tea in Northern Thailand. They introduced Assam tea seeds from India which is best for their location and its climate. Later, tea from Kenya and Sri Lanka were also planted which helps in contributing to the estate's diverse tea varieties (Rishi Tea, 2023). The tea estate focus on organic farming and emphasize that no chemicals are used. This commitment helps to promote organic farming as well as preserves the environment and improves quality and flavour of the teas (Karnjanatawe, 2020). Raming Tea Estate make use of both traditional techniques and modern innovations in terms of processing technology. They handpicked the finest tea leaves, and this delicate process has been practiced for over a hundred years. This selection which is time consuming and meticulous ensures that only the best leaves are used for production (Ramingtea.com, Thai Websites). The estate produces a lot of teas including black, green, oolong, and herbal infusions. Each tea undergoes different processing techniques to achieve its unique flavour profile. For example, black tea involves withering, rolling, oxidation, and drying, while green tea processing includes steaming or pan–frying to prevent oxidation, followed by rolling and drying (Terry & Sailom, 2008). Raming Tea Estate offers educational programs through the Asian School of Tea which is located on the second floor of their Raming Tea House in Chiang Mai. These programs provide comprehensive knowledge about tea cultivation, processing, and tasting for both beginners and professionals. The Raming Tea house, a café in a colonial–style building dating back to 1915 serves a variety of teas sourced directly from the estate, allowing guests to taste the unique flavours of tea (Changpuak Magazine and Maps, 2024). In conclusion, the Raming Tea Estate's dedication to

quality and sustainability has established them as a significant player in Thailand's tea industry.

One Gewog One Product of Bhutan

One such initiative Royal project by Her Majesty Queen Jetsun Pema Wangchuck, the Queen Consort of His Majesty King Jigme Khesar Namgyel Wangchuck, is the OGOP program, a Queen Project Officer (QPO) movement that seeks to empower local communities by promoting unique, high–quality products from each *gewog* (block or sub–district). Launched in 2015 by Her Majesty the Queen Mother, Ashi Dorji Wangmo Wangchuck, OGOP draws inspiration from similar models in other countries, particularly Thailand's One Tambon One Product (OTOP) program.

The core objective of OGOP is to harness the potential of Bhutan's rural spices, honey, herbal soaps, textiles, and traditional crafts–and helping them reach both domestic and international markets. Through OGOP, small–scale farmers, artisans, and producers receive support in product development, packaging, branding, quality control, and marketing. The program not only generates income for local communities but also preserves Bhutan's cultural heritage and promotes sustainable resource use.

Each product selected under OGOP is carefully curated to reflect the unique identity of its Gewog; while ensuring it meets quality standards. For example, organic black tea from the Samcholing community in Trongsa is one of the flagship products under the program. This tea is cultivated using traditional organic practices and is valued not only for its quality but also for the social and environmental impacts it creates—empowering women, fostering community collaboration, and maintaining ecological balance.

The OGOP program aligns closely with Bhutan's national development goals and several United Nations Sustainable Development Goals (SDGs), including poverty reduction, gender equality, sustainable economic growth, and environmental conservation. It also strengthens Bhutan's position in niche markets such as organic and fair–trade products, contributing to the country's image as a responsible and sustainable producer.

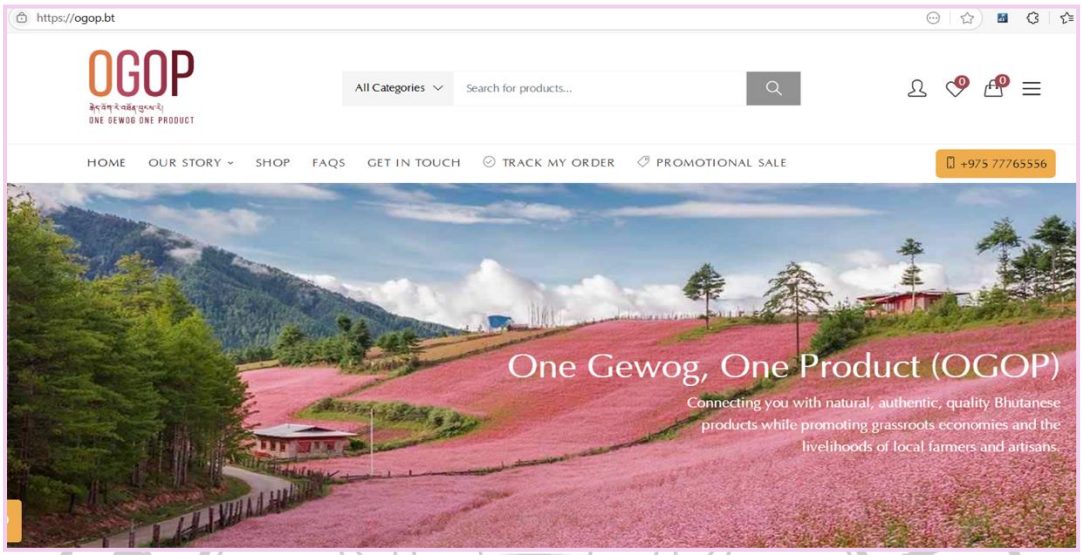


Figure 2.3 OGOP Homepage

Source: Website: https://ogop.bt/

As OGOP continues to evolve, it serves as a model of how community–based economic initiatives can preserve cultural identity, promote environmental sustainability, and create inclusive prosperity. By turning local strengths into marketable products, OGOP not only brings tangible benefits to rural Bhutanese communities but also offers a compelling story of resilience, pride, and innovation rooted in tradition.

The Story of OGOP: Empowering Bhutan's Rural Economies

Royal Vision and Cultural Roots

The One Gewog One Product (OGOP) project was launched on November 11, 2015, as a royal initiative under the Queen's Project Office, coinciding with the 60th birth anniversary of His Majesty the Fourth King. This initiative is inspired by One Tambon One Product (OTOP) model in Thailand. OGOP main aim is to identify at least one authentic product from each of Bhutan's 205 gewogs (villages) to promote rural development and cultural preservation. The project focuses on enhancing products from each gewogs andmaking them availabke in domestic and international markets, ultimately improving the livelihoods of rural people (kuensel Online, 2015).

The project focus on the use of local materials, traditional knowledge, and environmentally sustainable practices. Examples like Kishuthara textiles from Khoma gewog and blacksmithing crafts from Wochu in Paro shows the rich cultural heritage of Bhutan. Promoting such unique products ca help OGOP not only preserves Bhutanese traditions but also creates economic opportunities for rural communities.

OGOP's Socioeconomic Impact

Since it started, OGOP has significantly contributed to improving the socioeconomic well–being of Bhutan's rural coummunities. So far, the initiatives has benefited more than 100 farmers' groups and households across 80 gewogs (The Bhutanese, 2021). OGOP empowers farmers to add value to their products amd access larger markets and they were provided assistance in all phases of the production cycle starting from sourcing raw materials to marketing and distribution.

In 2019 OGOP purchases over 35 metric tons of goods worth Nu 20.1 million from farmers nationwide, nearly doubling the previous year's figures. This support has made a significant growth of small agribusinesses, farming cooperatives,a nd communities. OGOP also conducts training on sustainable resource management and other topics which enhance the capabilities of rural products.

From Local to Global

OGOP's vision goes beyond local markets, aiming to position Bhutanese products on the international platforms. There is a growing demand for OGOP products in countries like Japan, Singapore, Thailand, the USA, and Australia, despite the challenges tey faced such as limited transportation infrastructure (The Bhutanese, 2021). OGOP plans to address these challenges by establishing depots in border towns and explore altermative distribution channels through neighboring countries.

The initiative has also make use of digital platforms to expand its reach. OGOp serves as a key role for the Bhutan E–Commerce Portal, an online platform developed by the Royal Monetory Authority and Bank of Bhutan to sell Bgutanese products. They also havepartnerships with organizations like Drukair and it helped introduce OGOP products to airline passengers (Drukair, 2022).

Innovation and Entrepreneurship

OGOP has developed a framework to engage the private sector, entrpreneurs, and foreign investors for sustainable growth. The "Upscaling OGOP Project for

Engagement and Investments" framework inspire various models like joint ventures, foreign direct investment (FDI), and entreprenuership development for farmers and production houses (Kuensel Online, 2025). According to Bhutan's FDI Policy 2019, OGOP allows foreign equity participation ranging from 20% to 49%, with minimum investment requirements for agro–based and forest–based production projects.

This approach aspire to enhance local production through improved agricultural practices expand international markets for OGOP production, and foster sustainable rural development. OGOP also promotes innovation and creates employment opportunities by involving youth DeSuups, and Gyalsups in various project which contributes to the overall economic growth of Bhutan (The Bhutanese, 2025).

In conclusion, this chapter discusses various kinds of key concepts related to the production and value chain development of Bhutan organic black tea is grown without using any kind of synthetic chemicals, solely focusing on natural farming practices that promote environmental sustainability and high–quality tea. The process of black tea includes harvesting (hand–plucking or machine), withering, rolling, oxidation, and drying. QACCP are Important tool that ensure the quality and safety of the tea by identifying and controlling critical points during production. There are few organic certification bodies like USDA Organic and EU Organic which set strict standards for organic farming, ensuring that the tea meets international organic standards. Quality management system maintain consistent standards across the entire production process, from cultivation to consumer. The value chain of Bhutan organic black tea includes farming, processing, packaging, and marketing, each contributing to the final product's value. Bhutan face challenges such as limited access to modern technology, high production costs, and difficulties in meeting international certification standards. In other hand, country also has an advantage side like growing demand for organic products, a unique biodiversity, and favorable climatic conditions for tea cultivation. The global trend towards sustainable and organic products aligns well with Bhutan's green agricultural focus, which have a good opportunity for a success in both domestic and international markets.

CHAPTER 3

RESEARCH METHODOLOGY

Study Site

The research will be conducted in two distinct locations: Trongsa, Bhutan, and Chiang Ma and Chiang Rai, Thailand, both of which are relevant to the study of organic black tea production and value chain development.

Trongsa, Bhutan

Trongsa is in central Bhutan, and it is a key district known for its rising organic tea cultivation. It is located at an altitude of about 2,500 meters and it has favorable climate conditions for tea farming, particularly for organic black tea. Despite its potential, the region faces challenges related to quality control, inconsistent tea quality, limited infrastructure for processing, and a lack of formal quality assurance systems. The research will focus on developing a QACCP program to address these issues and improve productivity and quality assurance in Bhutan's tea sector. In addition, challenges such as unpredictable climate patterns and limited farmer knowledge on international best practices further complicate quality management in the region.

The current challenges in organic black tea in Bhutan is quality assurance where it is difficult to maintain consistent quality and implement a systematic quality control process. There are no formalized quality assurance systems which lead to some producers struggle in maintaining a product consistency and meeting global standards. The other challenges are the unpredictability climate in the region including heavy monsoons and occasional droughts which affect the growth of tea plants. In Bhutan, most farmers lack access to advanced tea processing technology and equipment which have an impact on the quality of the final product. Some farmers may be educated but some are not that much educated, and they have gaps in knowledge. Some of them lack knowledge and ideas of international best practices for

organic tea production and QACCP processes which is why the research is specifically focus on developing a QACCP program for the region.

Chiang Mai, Thailand

On the other hand, Chiang Mai which is in northern Thailand has a long history of tea production, particularly in higher altitude regions that provide the best conditions necessary for high–quality tea. The area has more established tea production systems, with a significant shift toward organic tea farming in recent years. Despite its advancements, Thailand's tea industry faces numerous challenges such as market competition and the need for more standardized quality control procedures. Many producers in Chiang Mai have experience with organic certification, but issues persist in maintaining consistent quality, particularly regarding quality control and value chain efficiency. The research in Chiang Mai will involve observing local tea farms and processing facilities, interviewing tea producers and experts, and analyzing successful practices that could be adapted for Bhutan. By comparing the experiences and practices in Chiang Mai with the challenges faced in Trongsa, the study will offer valuable insights into how QACCP systems and quality management practices could be tailored to the unique conditions in Bhutan to improve value chain development and enhance the competitiveness of Bhutan's organic tea industry. Through this comparative study, the research aims to create a comprehensive and practical framework for improving both the quality and productivity of organic black tea in Bhutan.

Chiang Rai, Thailand

Chiang Rai, Thailand, the cultivation of black tea has flourished due to the region's favorable climate, cool temperatures, and rich, fertile soil. Chiang Rai's red tea is known for its unique flavour profiles, ranging from malty and smooth to floral and slightly sweet, influenced by traditional processing methods and the region's distinct growing conditions. As part of this research, visits to local tea gardens and tea processing industries in Chiang Rai will be conducted to observe firsthand the cultivation, harvesting, and processing techniques used in the production of organic red tea. These visits will provide valuable insights into the practices employed in the region, contributing to the understanding of how quality control measures and industry

standards are implemented, and how these can inform improvements in Bhutan's own organic black tea production.

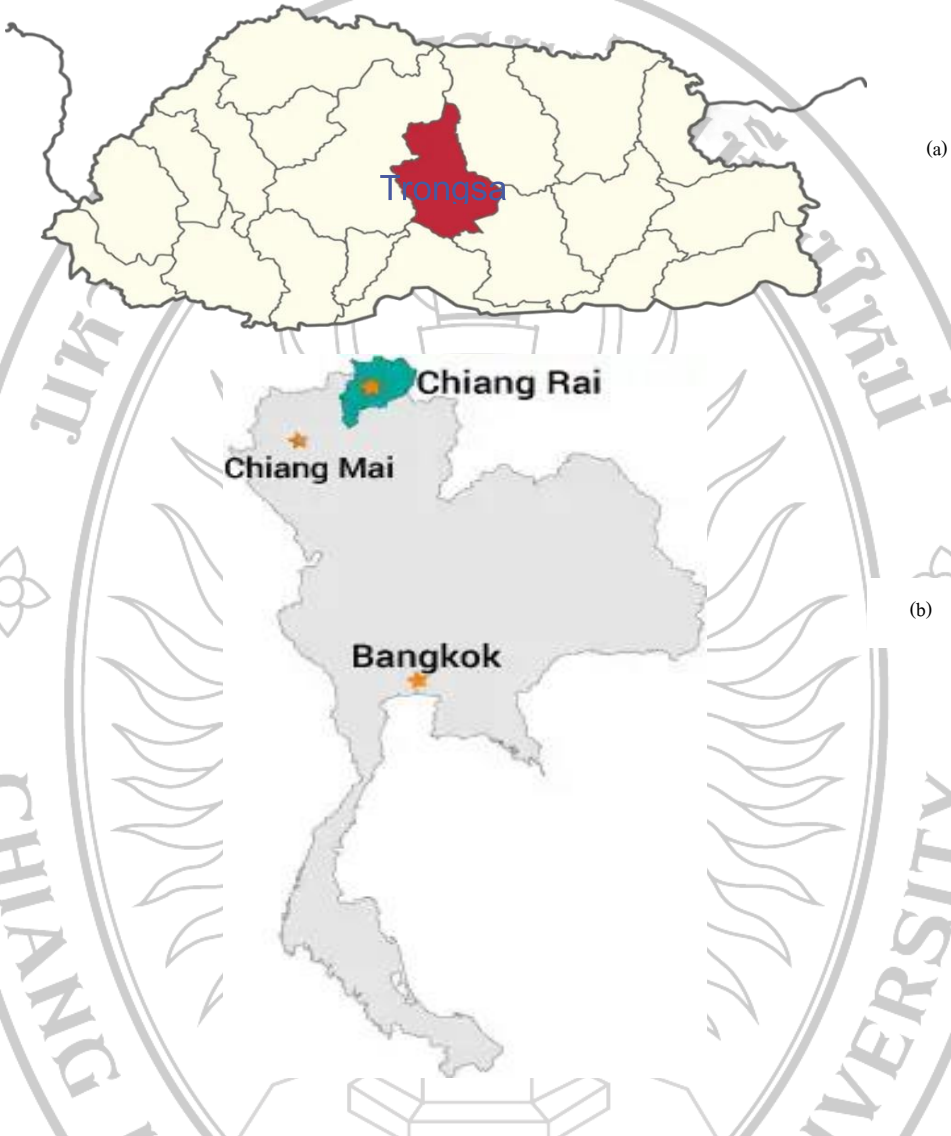


Figure 3.1 Study Site (a) Trongsa, Bhutan,
(b) Chiangmai and Chiang Rai, Thailand

Source: Trongsa District, 2024; Chiang Mai Travel Guide, 2024

Population and Sampling Group

The population and samples for this study focus on organic tea producers, tea processing facilities, and government regulatory bodies overseeing organic certification in Bhutan. Additionally, the research extends to include tea processing

facilities in Thailand specifically in Chiangmai as a comparative reference, particularly for the second objective related to value chain analysis. The study actively engages with key stakeholders, including tea producers, processors, marketers, and regulators, to ensure a broad and comprehensive understanding of the issues at hand. This approach allows for a richer analysis of the practices and challenges faced in both Bhutan and Thailand's organic tea sectors.

Samcholing Tea Cooperative, Trongsa, Bhutan

The Samcholing Tea Cooperative is in Trongsa which is in a central region in Bhutan is known for its lush landscapes and cool climate, suitable for tea cultivation. The cooperative is situated in a mountainous area that contributes to the unique flavours of its organic tea. The cooperative was established in the early 2000s as part of a community initiative to support and fulfill the goal of sustainable agriculture and provide a steady and consistent source of income for local farmers. It was originally started by a small group of families; the cooperative has grown as more farmers joined the cooperation after recognizing the benefits of working collectively. The Samcholing Tea Cooperative operates as a community–based organization. Members work together in all stages of tea production, from planting and harvesting to processing and marketing. The cooperative adheres to practices of organic farming, focusing on environmentally friendly farming techniques without the use of chemical pesticides or fertilizers.

Currently, the cooperative consists of around 50 active members, mainly from nearby villages in the Trongsa region. The membership is open to local farmers if they are interested in sustainable tea production and they can register and participate whenever they want, and new members are trained in organic farming practices. Members are involved in various activities such as planting, maintenance, and harvesting of tea crops. They are involved in every step they are required to take. They also participate in processing the tea leaves, which includes drying, packaging, and quality control. The group holds regular meetings to discuss production goals and community needs if they need any kind of improvements or financial support, and some members are also involved in promotional activities to expand their market. The cooperative produces high–quality organic green tea, black tea, and occasionally, herbal tea blends using native herbs. These teas are known for their distinctive

flavours, which are influenced by the favorable high–altitude growing conditions. The cooperative produces approximately 1,000 kilograms of tea per year, with a focus on quality over quantity. The production volume has gradually increased as demand for Bhutanese organic tea grows. The cooperative primarily sells its products locally within Bhutan which some are bought by OGOP (One Gewog, One Product), and some are collaborated with Druk Airline, catering to both residents and tourists. Recently, extra efforts have been made to explore international markets in hope of expanding more, particularly targeting eco–conscious consumers and specialty tea shops interested in unique, high–altitude organic teas. A manufacturing unit was established in 2009 with the financial support of GENTEC University, Republic of Korea and Royal Government of Bhutan. Recently, the group started a partnership with the nearby Samcholing High School to introduce young students to tea cultivation and processing (Samcholing Tea Cooperative, 2022).

The Samcholing Tea Cooperative was selected as one of the locations for this research mainly due to its unique location, sustainable practices, and community–centered approach. It is also because this cooperative is built by the royal family, and it has been there for ages since our forefathers. The location is also situated in a perfect place with cool climate ideal for tea cultivation and the cooperative produces high–quality organic tea. The cooperative supports local farmers which are only women through sustainable agriculture and environmentally friendly farming techniques using only organic fertilizers. With 50 active members empower women farmers to participate all stages of tea production and handling of machines and technology. It also stands as an example for other that traditional farming can be effectively aligned with modern market strategies as this cooperative has a strong collaboration with OGOP and Druk Airline which make this place an ideal case study for this research.

Figure 3.2 Black tea production at The Samcholing Tea Cooperative (1)

Figure 3.3 Black tea production at The Samcholing Tea Cooperative (2)

Doi Tung Development Project, Mae Fah Luang, Chiang Rai, Thailand

It is situated in the Mae Fah Luang District of Chiang Rai and is one of the significant contributors to Chiang Rai's tea and coffee industry. This is started in 1988 under the Mae Fah Luang Foundation, initiated by the late Princess Mother Somdet Phra Srinagarindra of Thailand. The place is well known for coffee cultivation but later they introduced tea and integrated into its sustainable development model. Doi Tung cultivates Assamica varieties of tea which is perfectly suited to the region's elevation and climate. They followed traditional black tea production techniques like withering, rolling, oxidation, and drying – along with modern machinery to ensure quality and efficiency. The tea is grown based on the model of sustainability and organic practices which align with the project's commitment to environmental conservation.

Tea farming at Doi Tung provides sustainable oncome for local ethnic groups like the Akha, Lahu, and Tai Yai. Tea cultivation is done in harmony with forest preservation and deforestation prevention. Visitors to Doi Tung can experience tea and coffee plantations firsthand and sample products at the Doi Tung Café. In conclusion, Doi Tung tea production is part of the project's holistic approach to sustainable development. Production commits to high–quality, environmentally friendly agriculture while supporting local livelihoods.

The Doi Tung Development Project in Chiang Rai was selected for this study because of the diverse integration of sustainability, social empowerment, and environmental conservation. They also support the ethnic groups such as the Akha, Lahu, and Tai Yai by promoting sustainable tea farming practices that incorporates the value of forest preservation and prevention of deforestation. The cultivation makes use of environmental–friendly techniques and modern machinery to ensure efficiency and consistency. This location is a role model for other tea production as they balance economic growth with environmental and social well–being, making it a good choice for study.

Raming Tea Estate, Black Tea Producer at Mae Taeng District, Chiang Mai

Raming Tea Estate is in Mae Taeng district, Chiang Mai, and it is one of the biggest and well–known black tea producers in Thailand. It is prominently known for a rich history rooted in the region's agricultural traditions. Established in the early

1940s, the enterprise started as a small–scale tea plantation aimed at utilizing the favorable climate and fertile soils of northern Thailand to produce high–quality tea. The founders create a sustainable source of income for local farmers while preserving traditional tea–growing methods. Over the decades, the cooperative has established its name in the Thai tea industry, blending heritage with innovation and technology to cater to both domestic and international markets.

The cooperative operates with a commitment to ethical and sustainable practices and focuses on environmentally friendly work processes. They have a diverse group of smallholder farmers, plantation workers, and processing experts who work collaboratively to maintain the high standards Raming Tea is known for. The enterprise provides thorough training and helpful resources to its members to improve end products to ensure safety and quality. The cooperative fosters a strong sense of community and shared purpose. Raming Tea aims to produce premium black tea and to improve the living standards of its members and contribute to the local economy. Its long–term goal is to expand its reach while maintaining its dedication to sustainability and authenticity with consistency, ensuring its reputation as a leader in the Thai tea industry.

The reason for the choice of this location is that the Raming Tea Estate is one of the oldest and most renowned black tea production. They utilize the fertile soils and favorable climate of northern Thailand to produce the premium black tea. They focus on ethical practices, environmental sustainability, and community empowerment and they also provide training and support to improve their quality. They combine the traditional method with modern innovations creating a sustainable income for local farmers. Raming Tea Estate is a prime example of how traditional farming can evolve to thrive in modern contexts.

Research Design

This chapter outlines the research design and methodology aimed at improving the quality and productivity of Bhutan organic black tea. It focuses on building QACCP program and analyzing the value chain for black tea production. The primary goal is to enhance both the productivity and quality of organic black tea through the development of the QACCP program and value chain analysis. The methodology is structured to ensure the reliability, validity, and accuracy of the findings, incorporating both quantitative and qualitative approaches.

Semi–structured interviews are suitable for qualitative research to collect data and information regarding the productivity and efficiency of black tea production facilities. The collected data are analyzed using gap analysis and root cause analysis.

The research design employs descriptive and analytical strategies to provide a holistic view of the black tea production process. A case study approach is utilized, focusing on organic black tea producers and processing units in Bhutan and Thailand. The study aims to: 1) build a QACCP program tailored for black tea producers in Bhutan and 2) redesign the value chain to enhance competitiveness and value creation in Bhutan organic black tea industry.

The research involves reviewing existing literature, documents, and reports. Field observations will be conducted by visiting various tea gardens in Chiang Mai and Chiang Rai, Thailand, to analyze equipment, techniques, and operational efficiencies.

This research will employ purposive sampling where organic tea producers and processing facilities in Bhutan and Thailand are selected based on their relevance to the study. This also includes government regulatory bodies overseeing organic certification.

This research will start with situational analysis followed by analysis of quality management (SWOT and Gap analysis), QACCP program, trial, evaluation, improvement (SBM model and VRIO analysis), building a QACCP manual, and then implementation which will help set the position of Bhutan organic black tea.

Research Instruments

The set of tools used to address Objective 1: To analyze and design the value chain of Bhutanese black tea includes semi–structured interviews, SWOT analysis, root cause analysis, fishbone diagram, the Synthetic Business Model, and VRIO analysis, as detailed below.

Semi–structured Interviews

This approach is ideal for qualitative research to explore insights, challenges, and recommendations from stakeholders to improve the quality of the organic black tea. Through this method, in–depth perspectives from tea producers, processors, distributors, and consumers would be vital to fulfill the research aims to design a QACCP program and analyze the value chain. For the development of QACCP, interviewing tea producers and workers to understand current challenges in quality control, process, pain points and focusing on areas like pest control, handling, processing, storage, and transport. For value chain analysis, interviewing stakeholders like producers, suppliers to understand the current flow of the value chain, costs, bottlenecks, and opportunities for improvement. These interviews are usually easy to conduct with local tea growers and to reach out to farmers' cooperatives or industry groups.

SWOT Analysis

A SWOT analysis is a strategic tool used to identify the internal and external factors that can have an impact on any kind of specific objective. The SWOT analysis will guide to assess the strengths, weaknesses, opportunities, and threats related to its production, value chain, and marketing, particularly in Bhutan.

Using SWOT analysis in research will help to systematically examine each factor impacting organic black tea production in Bhutan. It will provide a framework for identifying areas that need strategic attention, opportunities for market expansion, and potential risks that require mitigation. This approach can complement your VRIO analysis by focusing on both internal resources and external market factors.

Root Cause Analysis

Root Cause Analysis (RCA) is a method used to identify the fundamental causes of a problem or defect. RCA seeks to uncover the underlying issues in order to implement long–term, sustainable solutions and prevent recurrence. Common tools used in RCA include the "5 Whys Technique", where one repeatedly asks "Why?" until

the root cause is identified. In this study, Root Cause Analysis (RCA) was applied through guided questioning to identify and analyze existing gaps in performance, internal processes, and market and distribution mechanisms. This approach enabled the research team to uncover critical weaknesses and recommend targeted improvements across the organic black tea value chain.

Fishbone Diagram

The Fishbone Diagram, also known as the Ishikawa Diagram or Cause–and–Effect Diagram, was used as a supporting tool in Root Cause Analysis (RCA). This diagram helps systematically identify and categorize the potential causes of a specific problem by organizing them into key contributing factors such as Man (People), Machine, Method, Material, Measurement, and Environment.

In this study, the Fishbone Diagram was applied to visually map out the possible sources of gaps in performance, processes, and market and distribution systems within the organic black tea value chain. By doing so, it facilitated a deeper understanding of the root causes behind observed challenges, thus enabling the development of more targeted and effective solutions.

The Synthetic Business Model

The Synthetic Business Model (SBM) is an integrated framework designed to help businesses understand, analyze, and design their value proposition, operations, and overall strategy. It is particularly useful in crafting business models that are innovative and adaptable to specific market environments, helping organizations optimize their resources while ensuring sustainable growth. The SBM typically combines strategic elements like business processes, technology integration, customer value, and financial management in a cohesive manner to achieve long–term success. Through this method, a new value chain is designed. Any gaps and opportunities to be filled, this strategy can propose a new solution to reduce any issues.

Figure 3.4 The Synthetic Business Model Canvas

Source: Key Partners Key Activities Value Proposition Customer Segments, 2024

VRIO Analysis

The VRIO analysis is a strategic framework used to evaluate resources and capabilities to understand a projects or business's potential competitive advantage. It stands for Value, Rarity, Imitability, and Organization. For your research on organic black tea productivity in Bhutan, VRIO analysis can help assess the unique strengths and sustainability of the tea sector by examining whether its resources and capabilities provide a competitive edge.

Using VRIO analysis in research on organic black tea will help identify if Bhutan organic tea production has sustainable competitive advantages. It provides a structured approach to assess if the tea sector's resources can deliver long–term benefits by being valuable, rare, hard to imitate, and effectively organized. This analysis, combined with SWOT, will give a comprehensive view of how Bhutan's organic black tea sector can thrive and grow in a competitive environment.

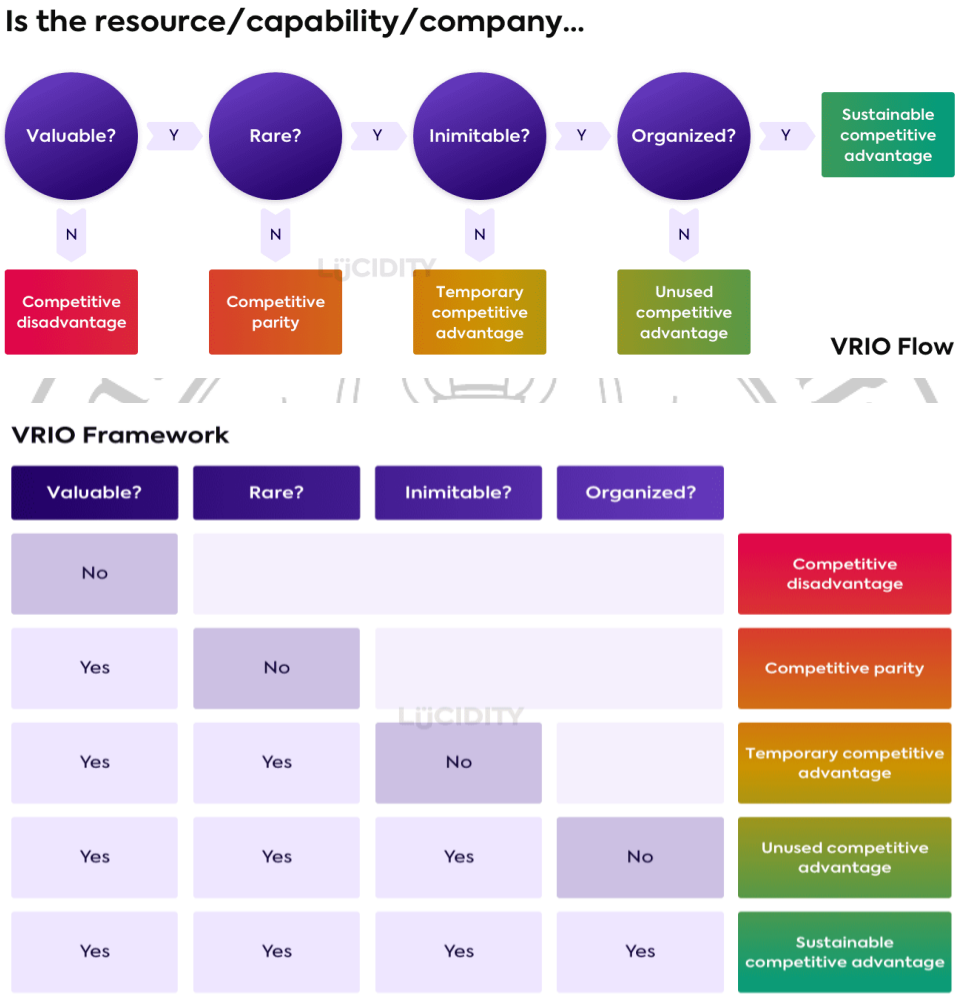


Figure 3.5 VRIO Flow Chart and VRIO Framework

Source: The VRIO Framework: A Tool to Effectively Evaluate Your Strategy, 2024

The set of tools used to address Objective 2: To develop a QACCP program for black tea production. The tools used in this study include QACCP and value chain surveys, integration systems of organic black tea through QACCP, HACCP, and GMP, identification of potential Critical Control Points (CCPs) using the CCP Decision Tree, and laboratory analysis, as detailed below.

QACCP and Value Chain Surveys

This method is applicable to gather quantitative data from a larger number of respondents in a short period of time. For QACCP development, producers and workers are asked about their awareness, challenges they face, and the effectiveness of existing practices. They are provided with open–ended questions. For value chain analysis, the data is collected on the transportation costs, processing time, profit margins, and quality losses in the value chain. This method can be done by distributing questionnaires through online to Bhutan and in person in Chiangmai, and Chiang Rai in Thailand.

Designing an Integrated QACCP System in Connection with HACCP and GMP for Organic Black Tea Production

The framework for organic black tea production is designed to integrate three key systems: Quality Assurance Critical Control Points (QACCP), Hazard Analysis and Critical Control Points (HACCP), and Good Manufacturing Practices (GMP). This integrated approach aims to enhance product quality, manage risks, and ensure safety throughout the production process, as illustrated in Figure 3.6 Specifically, QACCP is used to identify and manage Quality Control Points (QCPs), HACCP to identify Critical Control Points (CCPs) for risk mitigation, and GMP to establish Standard Operating Procedures (SOPs) that uphold hygienic conditions during production.

The development of criteria for selecting and integrating these control systems was informed by a combination of preliminary data, literature review, field observations, and consultations with experts from GMP–certified facilities (e.g., Doi Tung Top Tea) and HACCP–certified factories (e.g., Sermluk Thai Tea Co., Ltd.) in Chiang Rai, Thailand. These insights were instrumental in screening and selecting the most appropriate control systems for application across the Bhutanese organic black tea value chain.

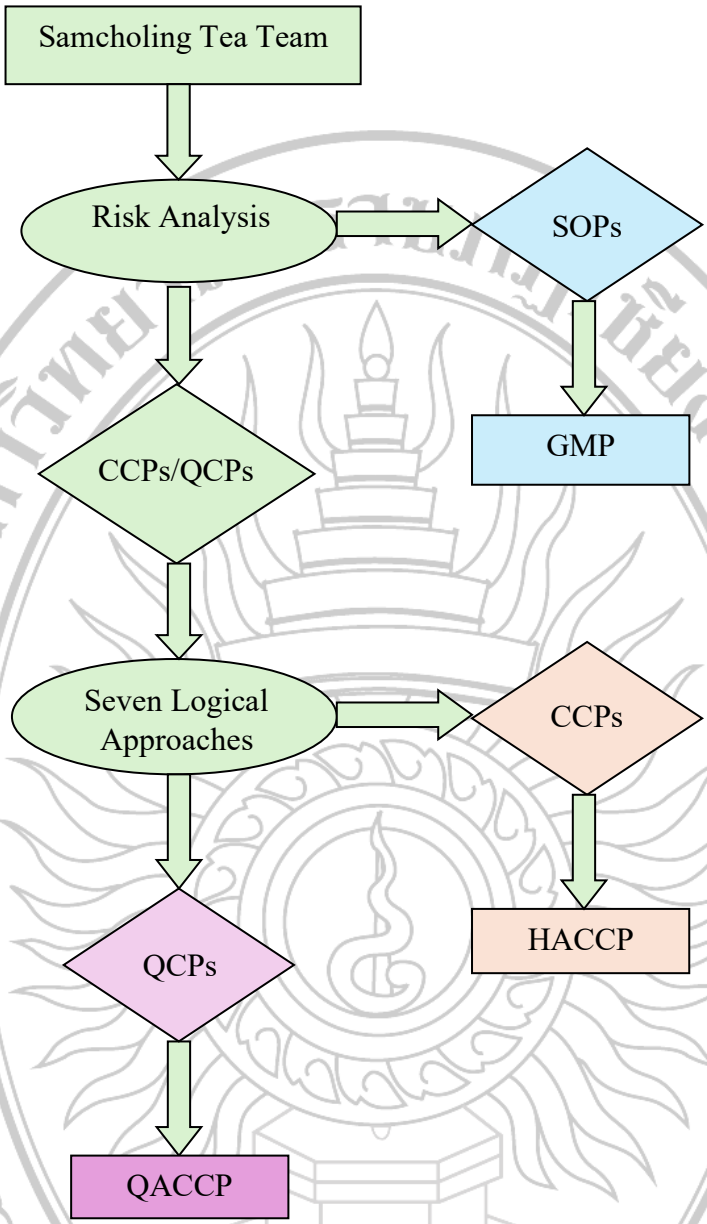


Figure 3.6 Integration systems of organic black tea through QACCP, HACCP and GMP

GMP serves as the foundational system to manage environmental factors at the Samcholing Tea Cooperative. This includes oversight of production sites, machinery, equipment, personnel hygiene, transportation of raw materials and finished products, and product labeling. While GMP do not directly address product quality or

safety, they provide essential baseline controls. In this study, a risk analysis methodology adapted from Ahmad et al. (2019) was applied. It assesses the Severity (S) of health hazards and their impact on product sensory quality—derived from historical sales data and consumer complaints—on a scale of 1 to 4 (Table 3.1). This is combined with the Probability (P) of occurrence, also ranked from 1 to 4 (Table 3.2). The product of S × P determines the risk level; a score below 8 indicates a non–significant risk that can be managed through SOPs.

HACCP is utilized for managing health hazards that are not adequately controlled through GMP. It involves identifying CCPs, control measures, critical limits, monitoring procedures, corrective actions, and documentation responsibilities. The risk classification process adapts the seven logical steps of HACCP Ahmad et al. (2019) as shown in Table 3.3, using seven variables (A–G) each assigned a risk level (low, medium, high). The cumulative score determines the significance of the hazard; a score between 17–21 signifies a high–risk hazard requiring CCP–level control. The CCP decision tree, in accordance with the 2023 CODEX guidelines, is then used to verify whether the identified hazards are indeed critical within the organic black tea production process.

Identify Potential CCPs (CCP Decision Tree)

A Critical Control Point (CCP) Decision Tree is a systematic tool used in HACCP management systems to determine if a process step should be considered a CCP. A CCP is essential for food safety management, as it is a point in the production process where a specific hazard (biological, chemical, or physical) can be controlled to an acceptable level, prevented, or eliminated. The decision tree helps in identifying these points, ensuring effective hazard control measures. The decision tree is one of the most important parts of developing a HACCP plan, as it clarifies which steps in the process require critical assessing and control. The CCP decision tree is made according to industry standards, which is normally referenced from the Codex Alimentarius Commission, an internationally recognized guide for HACCP implementation. The figure below explains if each step should be classified as be CCP or not. Then the critical control points are prioritized according to their significant impact on the quality and the solutions to improve the issues. The new ideas and

strategies learned from Thailand tea industry are then applied to solve the highest critical control points that have high impact on black tea quality.

Table 3.1 Evaluation of the severity level (S) of health hazards and quality rejection of black tea

Category	Criteria	Score
Limited	The control of the production environment does not meet standards and has never had a history of causing serious health risks or impacts on black tea quality.	1
Moderate	The control of the production environment meets standards and has a history of causing serious health issues, such as reported illnesses by consumers, or black tea quality impacts, such as sensory acceptability or contamination with foreign materials that do not affect health but are still accepted by consumers without complaints.	2
Serious	Control of the production environment meets standards and has an impact on health, affecting the immune system, causing allergies, medical visits, or illnesses that require rest and treatment. It may also lead to product quality issues, such as falling tea standards, consumer complaints about quality, or product returns.	3
Very serious	The control of the production environment meets standards and impacts health, affecting the immune system to the extent that medical treatment and rest are required, causing chronic diseases, disability, or even death. It may also affect product quality, such as falling tea safety standards, leading to lawsuits between consumers and producers, which may result in both temporary and permanent cessation of production.	4

Table 3.2 Evaluation of the probability level (P) of health hazards and quality rejection of black tea

Category	Criteria	Score
Very small	The risk of harm is very minimal, and if any hazards exist, there are subsequent steps in production to reduce the risks to a level that does not impact health, with a minimal effect on quality during production or on the final product.	1
Small	Health hazards may occur 1–2 times within a year, or there may be changes in product quality during production that deviate from the standards or scientific/research references, but these can still be corrected and adjusted back to the original standards.	2
Medium	Health hazards may occur 1–2 times within 6 months, or there may be a noticeable change in quality during production that deviates from the standards, requiring the product to be withheld from distribution because production cannot be corrected or adjusted to meet the original standards. However, the final product may be blended with other tea products for sale.	3
High	Health hazards occur frequently, almost every time during production. If production is not strictly controlled, it will significantly degrade the quality during processing, to the point where it cannot proceed to the next stage. As a result, the final product will not meet standards, and consumers will be affected.	4

Table 3.3 Variables of seven logical approaches for classification HACCP and QACCP

Variable	Criteria
A	The impact of the identified food safety hazards concerning the level of control applied
B	The practicality of monitoring, such as the ability to track it promptly to allow for immediate corrective actions
C	The position of the control measure within the overall system compared to other measures
D	The likelihood of failure in the control measure or considerable variations in the processing
E	The serious consequences if the control measure fails
F	Whether the control measure is specifically designed and implemented to eliminate or significantly reduce the hazard level
G	Synergistic effects, meaning the interaction between two or more measures that results in a combined effect greater than the sum of their individual effects

QACCP focuses on managing quality–related aspects of black tea that influence its sensory and market value but do not pose health risks. This includes characteristics such as moisture content, chemical composition (e.g., caffeine, theaflavin/thearubigins), appearance, aroma, taste, stem contamination, and the presence of small foreign objects. It also covers pesticide residues within organic standards and origin traceability. Failure to control these factors during various production stages can lead to consumer rejection and diminished product credibility. When the total score from the seven logical variables is below 17, the issue is managed through QCPs under the QACCP framework.

The overall risk assessment for both consumer safety and product quality are based on calculated severity and frequency scores. These scores inform the integration and application of control measures across the three systems–GMP for basic hygiene,

HACCP for critical hazard control, and QACCP for maintaining quality and sensory integrity throughout the organic black tea value chain.

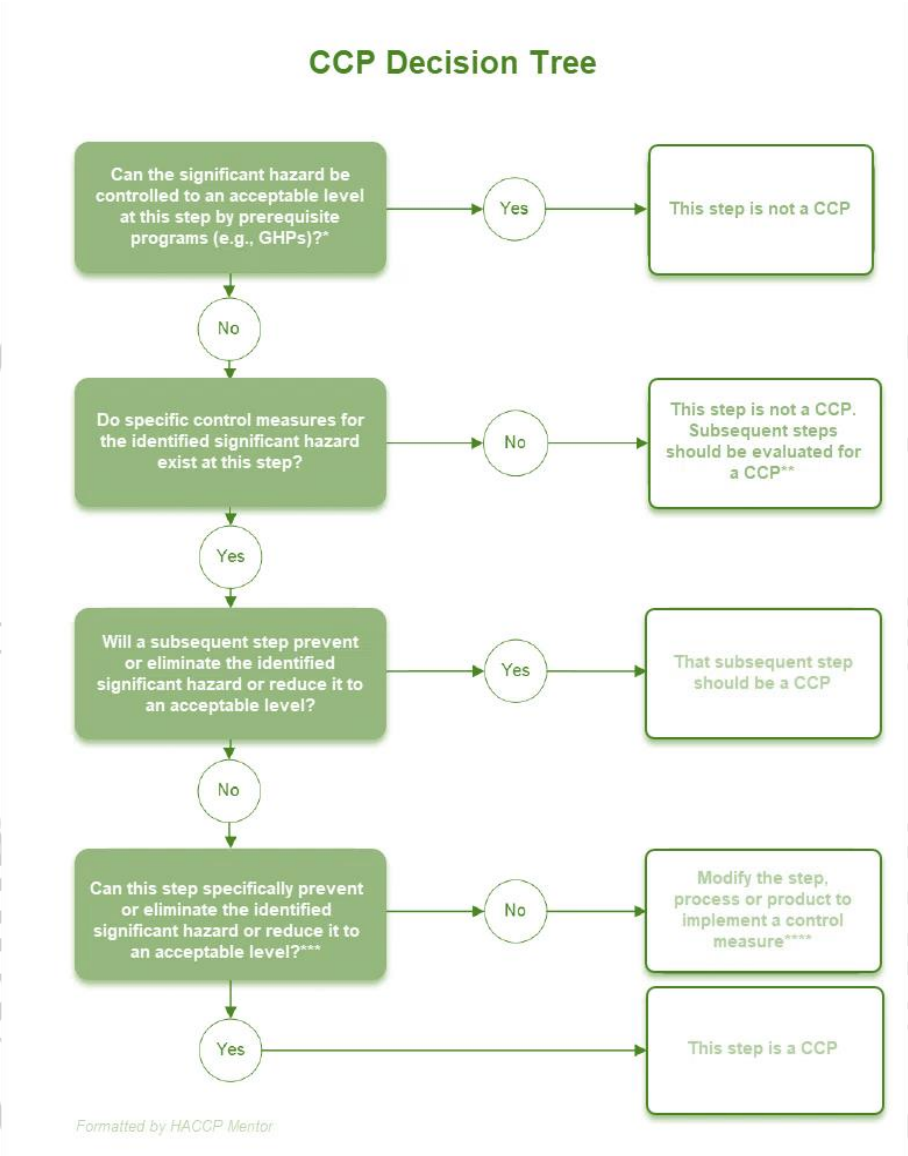


Figure 3.7 CCP Decision Tree

Source: Revised CCP Decision Tree adopted by Codex (2023)

Laboratory Analysis of Black Tea

This research will contain numerous laboratory tests on black tea from Chiangmai and Chiang Rai to assess several quality parameters. The collected data would be helpful to evaluate the overall quality and safety of the product which will be helpful to the tea growers in Bhutan. the analysis will include the measurements of % yield to determine the efficiency of tea production, % tea stalks to check the proportion of leaves to stalks, and moisture content to assess drying and prevent mold formation. Others include Total Ash content to check the mineral composition, caffeine and catechin levels will be indicator to provide an insight into chemical profile. The total phenolic compounds to determine their antioxidant properties which contribute to the tea's health benefits. Additionally, antioxidant analysis to assess the health benefits and microbial analysis to determine the total plate count and to check the potential contaminants such as *Staphylococcus aureus* and *Salmonella*, ensuring the tea meets the safety and hygiene standards. Lastly, sensory analysis to assess the characteristics like taste, aroma, appearance, and overall quality of the black tea, which the information will help to meet the desired requirements of a consumer as well as market acceptability. These laboratory analyses will help to provide a comprehensive insight on raising the overall standards of a black tea in relate to the quality, safety, market value and sustainability of the product.

Data Collection

Document analyses will be carried out on relevant government reports, literature, and existing regulatory guidelines to understand the framework governing organic black tea production. Additionally, observational studies will be conducted during visits to processing facilities to observe the effectiveness of operations, the use of equipment, and quality control processes firsthand. The study also utilizes secondary data sourced from existing reports and studies to supplement primary data collection. Data collection occurred in different phases.

For the first objective–building a QACCP program–data is gathered from organic tea producers in Bhutan through surveys and interviews. These instruments aimed to uncover current practices and challenges in black tea production while identifying areas for further improvement. Field visits to processing facilities in

Chiangmai and Chiang Rai allowed for direct observation of operational processes, while document analysis helped identify gaps in existing quality assurance systems. Questionnaires will be distributed to the local tea growers to get valuable insights on tea processing, especially on the quality and safety of the products and the overall value chain.

The second phase, focused on value chain analysis, involved a combination of surveys and interviews to map the black tea value chain in Bhutan. Observational data from tea processing facilities in Thailand provided a comparative perspective for evaluating Bhutan's production system. Secondary data collection concentrated on reviewing existing studies on tea value chains and sustainable business models, offering broader context for understanding the industry's dynamics.

The critical control points of each step in the black tea process were noted, and pre–laboratory tests were conducted to maintain quality. These steps were then compared with practices in other tea industries, allowing for the selection of the best methods for Bhutan's black tea production. Pre–laboratory tests included evaluating black tea samples from Chiang Mai and Chiang Rai for moisture content, ash content, antioxidant properties, and phenolic compounds.

Data Analysis and Statistical Used

The data analysis was structured to align with the two research objectives. For the QACCP program, root cause analysis was employed to identify the underlying issues in the production process and the challenges associated with them. The gap analysis method compared current practices with the desired outcomes under the QACCP framework. Identifying CCPs was a key aspect of this analysis, as it helped pinpoint specific stages in the production process where interventions could significantly enhance quality control. CCPs are analyzed using a Pareto strategy.

For the value chain analysis, SWOT and VRIO analyses were applied to assess the strengths, weaknesses, opportunities, and threats present in the current value chain. This analysis highlighted areas where Bhutanese black tea producers could gain a competitive advantage. Supply chain mapping was also utilized to visually represent the stages involved in the tea production process, from raw material procurement to the final product reaching consumers. To ensure sustainability, the Synthetic Business

Model (SBM) was applied to propose strategies that could enhance the environmental and economic sustainability of the black tea value chain.

Ethical considerations were paramount throughout the research. Participants were informed about the nature of the study and their voluntary involvement, with informed consent obtained from all participants before data collection. The confidentiality of participants was respected, with all data anonymized to safeguard their identities. Special care was taken with sensitive information from regulatory bodies and tea producers, ensuring that all collected information was solely for research purposes and not shared with unauthorized parties.

While the study aims to provide a comprehensive framework for enhancing black tea production and its value chain, it faced several limitations. Logistical challenges arose due to the geographical scope of the research, particularly in accessing remote tea processing facilities in Bhutan. Time constraints also limited the depth of some interviews and observations. Additionally, some stakeholders were unavailable or unwilling to participate or share information, which restricted the scope of data collection. These factors may have influenced the comprehensiveness of the data gathered.

In conclusion, this chapter outlines the various methodologies integrated into the study to achieve the research objectives. By combining qualitative and quantitative methods, the research provides a holistic view of the black tea production process in Bhutan and offers practical solutions for improving quality assurance and the value chain. The methodologies presented here are designed to ensure that the research findings are robust, reliable, and reflective of the realities of the black tea industry in Bhutan.

CHAPTER 4

RESULTS AND DATA ANALYSIS

Situation and Value Chain Analysis of Black Tea Production in Bhutan

This chapter outlines the results of the study of a Samcholing tea grower struggling with the challenges they are currently facing regarding the black tea quality. The data is based on the online interviews conducted with the experts and the farmers in Samcholing estate.

The main two objectives of the research are:

1. To analyze and design the value chain of Bhutan black tea. This objective aims to study the current value chain for Bhutan organic black tea, identify key factors for improvement, and propose a redesigned value chain that enhances value creation and competitiveness.

2. To develop a QACCP program for black tea production. This objective focuses on addressing the pain points and challenges faced by black tea producers, aiming to create a systematic approach to quality assurance.

The information obtained from the interviews and open–ended questions are studied using three methods– SWOT analysis–Gap Analysis and Root Cause Analysis to determine underlying issues and potential solutions. Firstly, SWOT analysis is evaluated for weaknesses and threats and then Gap Analysis is done using different types of analysis such as Performance Gap, Process Gap, and Market and distribution Gap.

1. SWOT analysis

SWOT analysis presents strengths and weaknesses within the group, as well as opportunities and threats from outside, by reporting in four dimensions: natural resources, economic, well–being, and social aspects. The results are as follows:

Table 4.1 SWOT analysis of Bhutan organic black tea

Strength	Opportunity
Natural resources	***Natural resources***
– Pure organic, uses natural compost like cow dung and hen uric. – Unique background, clean environment.	– Growing global demand for organic products.
Economics	***Economics***
– Follows international standard certified by Bhutan Food and Drug Authority (BFDA) and OGOP, appealing to export markets.	– High international demand (USA, Germany, Canada, Russia, Netherlands).
Well–being	***Well–being***
– Health benefits, such as reducing pressure and managing weight, make it attractive to health–conscious consumers.	– Increasing local interest due to health benefits (pressure reduction, weight management).
Social engagement	***Social engagement***
– The product has a unique identity tied to Bhutanese heritage, which enhances its global appeal.	– Potential for online marketing and promotions *via* Facebook, Instagram, and TikTok.

Table 4.1 (Cont.)

Weaknesses	Threats
Natural resources	***Natural resources***
– Soil quality needs improvement with fertilizers.	– Heavy rain and cloudy weather affecting production.
– Irrigation issues (limited water supply).	
– Quality inconsistency across batches.	
Economics	***Economics***
– High production costs due to reliance on imported machinery and packaging materials.	– High international shipping costs.
Well–being	***Well–being***
– Inconsistent quality across batches affects consumer trust.	– Limited knowledge of rolling, withering, and fermentation processes. – Poorly optimized production methods, leading to variations in taste and quality.
Social engagement	***Social engagement***
– Limited training and knowledge about modern processing techniques, such as rolling, withering, and fermentation.	– Limited consumer awareness in some markets due to insufficient marketing efforts.

In summary, the key limitations in the production of Bhutanese black tea are as follows: Agricultural factors, including soil quality, water supply, and proper cultivation practices to ensure healthy tea plants and high–quality leaves. Dependence on imported machinery and packaging materials, which can be costly and difficult to access. Inconsistent production quality, due to challenges in controlling and standardizing the tea–making process and human resource development, which is critical for effectively managing the entire tea production value chain to consistently meet market demands in both quality and quantity.

2. GAP analysis

Gap analysis conducted with Samcholing community members and study visit to Chiang Mai and Chiang Rai resulted in the identification of three key gap areas: Performance Gap, Process Gap, and Market and distribution Gap. RCA (Root Cause Analysis) is a tool used to conduct in–depth analysis by repeatedly asking "Whys Technique" to group members, to support the gap analysis. The findings are summarized using a Fishbone diagram, followed by interviews to explore solutions and research recommendations. The details are as follows:

2.1 Performance gap analysis

This analysis highlights the differences between the current practices in black tea production in Thailand and the desired ideal standards, focusing on operational efficiency, quality consistency, and market fulfillment. The assessment was guided by the following four key questions:

Q1 Why do some struggles of production areas?

Q2 Why is irrigation difficult?

Q3 Why is infrastructure inadequate?

Q4 Why is investment low?

The study reveals that while current black tea production generally meets market demand, it suffers from inconsistent batch quality and performance issues that hinder overall productivity and product quality. A key challenge is the lack of effective natural resource management. Some production areas face inadequate sunlight and irrigation. Limited access to water, poor infrastructure, high production costs, low investment, continued reliance on traditional farming methods, and

insufficient government support are likely root causes of these underperformance issues.

2.2 Process gap

This is one of the critical performance gaps that affects tea quality across different batches. Although the standard steps—such as withering, rolling, oxidation, and drying—are followed, variations in the final product still occur. These inconsistencies manifest as bitterness, white–red discoloration, and poor aroma. Such defects are largely attributed to differences in rolling pressure, fermentation time, and moisture retention. Batches that fail to meet quality standards are returned to farmers for personal use instead of being sold, resulting in revenue loss and product waste.

Insights from Bhutanese tea producers have clearly revealed production process gaps through the following questions:

Q1 Why is tea quality inconsistent?

Q2 Why do these variations occur?

Q3 Why is there a lack of experience?

Q4 Why are training programs not implemented?

Q5 Why is external support limited?

The inconsistency in tea quality is likely due to varying conditions during the rolling, withering, and fermentation stages. Table 4.2 below provides a comparison of black tea processing between Trongsa (Bhutan) and Thailand.

One major challenge is the lack of tea experts to provide hands–on training to workers. While producers have received both online and practical training from various international experts, there remains a pressing need for more intensive, hands–on instruction—particularly in critical stages such as oxidation control, rolling techniques, and withering durations.

Without structured training programs and well–researched production protocols, the product outcomes remain inconsistent. Additionally, limited opportunities for tea workers to visit factories abroad and a lack of skill development initiatives–such as standard operating procedures for producing consistent, premium–quality black tea–pose further barriers to improvement in the industry.

The Samcholing tea production facility is equipped with basic machinery, including roasting, drying, and rolling machines (Figure 4.1). However, these are insufficient to optimize the tea processing stages. The current rolling machine, in particular, suffers from drying inefficiencies, which negatively impacts the final texture of the tea leaves.

A major challenge faced by the facility is the absence of essential monitoring tools, such as moisture meters and temperature–time controllers. These instruments are crucial for regulating heat exposure and drying duration–two factors that significantly influence product consistency and quality. Without them, variations in processing conditions continue to contribute to inconsistent tea quality.

Table 4.2 Comparison of parameters to analyze the Process Gap in fermented tea production between Bhutan and Thailand

Processing steps	Samcholing, Bhutan	Doi Tung Project, Chiang Rai	Raming Tea Estate, Chiang Mai
Harvesting	9am – 5pm	5:00 am – 7:00 am	5:30am – 7:00am
Withering	10 – 18 °C, 20 hours	26 °C, 81 % RH, 45 – 50 minutes	12 – 20 hours
Rolling	4 hours	20 minutes	30 – 60 minutes
Oxidation	2 days	12 – 18 hours	20 – 30 °C, 90 % RH, 45 min – 3 hours
Drying	110 °C for 30 minutes	100 °C for 24 minutes	90 – 110 °C, 20 – 40 minutes

Figure 4.1 The basic equipment in Samcholing tea production

2.3 Market and distribution Gap

Despite the inconsistency in black tea quality, demand remains high due to the unique characteristics of tea grown at high altitudes in Bhutan, combined with small–scale production and limited market access. Consumers include both domestic buyers and international markets such as Germany, the USA, and Canada. The Samcholing tea estate operates its own retail shop and distributes its products through various local outlets, including OGOP stores, shops across Bhutan, and Paro International Airport. Domestic shipping is offered free of charge, and there are currently no logistical challenges within the country. Some root cause questions below were stated to the Bhutan tea producers for market and distribution barriers.

Q1 Why is international shipping expensive?

Q2 Why are these costs high?

Q3 Why is bulk shipping not used?

Q4 Why is production small–scale?

However, the estate faces significant obstacles in international distribution–primarily due to high logistics costs and the lack of online sales channels. Limited production volumes and the absence of bulk shipping options further constrain Bhutan's tea exports. To overcome these barriers, the ideal solution would involve establishing cost–effective international logistics and expanding into online sales platforms. As the root cause results mentioned above, Fishbone Diagram or Ishikawa diagram is a visual tool for root cause clarification which helps to identify and

categorize the potential causes of a problem. It is structured like a fish skeleton, with the problem at the head and potential causes branching out as bones (Figure 4.2).

Based on the Fishbone diagram and interviews with tea producers, the development strategy has been summarized according to the identified gaps as follows:

Performance Gap – Collaborate with local and international tea experts to provide specialized training and enhance technical knowledge.

Process Gap – Introduce practical, hands–on sessions focused on machinery operation and quality control. Conduct regular workshops on tea processing, implement structured Standard Operating Procedures (SOPs), and enforce consistent quality checks throughout all stages of production.

Market and Distribution Gap – Develop digital sales platforms, including dedicated websites and e–commerce stores. Establish export partnerships to reduce shipping costs and strengthen the brand's presence on social media to engage international consumers more effectively.

Figure 4.2 Fishbone diagram on black tea production challenges in Bhutan

3. Enhancement of value chain of Bhutan organic black tea

Porter's Value Chain Model is one of the practical models which provides a detailed and comprehensive framework to analyze the various activities that are involved in organic black tea production, starting from sourcing raw materials to

delivering the final product to consumers. This model is divided into two main parts– Primary Activities and Support Activities. Primary Activities are directly involved in production and sales whereas Support Activities help to enable efficient operations and competitive advantages. Utilizing this model will help to dive deeper into Bhutan's tea production about their strengths, challenges, and opportunities within the industry.

3.1 Primary Activities in the black tea value chain

The primary activities in the Bhutan black tea value chain include five key components: *inbound logistics*, which cover tea cultivation, harvesting, and transportation of raw leaves to processing facilities; *operations*, involving the processing of black tea to achieve the desired quality; *outbound logistics*, which refer to the distribution and transportation of the finished tea to retail and export points; *marketing*, aimed at promoting Bhutan black tea in both domestic and international markets; and *service*, which includes customer support and ensuring satisfaction throughout the post–purchase experience.

1) Inbound Logistics

Inbound logistics in black tea production involves the handling of tea sourcing, harvesting, and the transportation of raw tea leaves to processing facilities. Black tea cultivation in Bhutan is unique because it is deeply rooted to tradition, and it dated back to forefathers. It still follows the traditional farming practices who preserve the culture and tradition. The tea is planted in 60 acres of land and the farmers manually picked them up during harvest time to ensure quality. The harvest time starts from March to October, and the tea leaves are carefully plucked to maintain the integrity of the final product. So many issues arise in this stage one if which is the high moisture content leading to inconsistencies in flavour and aroma. Some tea areas face the challenges of poor irrigation systems and low sunlight exposure leading to different quality and yield. Bhutanese black tea is the pure organic product and as much as it has an advantage and a good selling point, heavy dependence on traditional fertilizers and limited soil improvement measures affects the large–scale productions and sale.

The entire harvesting process is manual where the farmers must transport the collected tea leaves from farms to processing units in a timely manner to prevent spoilage so oftentimes the efficiency and the quality of the workflow is

compromised. The nature of the work is labor–intensive and the pressure for the workers to challenge themselves against time to maintain the high quality and integrity. The challenges can be solved if the bottlenecks that arise from this step are carefully handled by plucking technique improvement, planning better logistics, by investing in cost–effective and efficient transport systems, and by improving storage facilities.

2) Operations of Black Tea

The multiple processing stages are involved in transforming raw tea leaves into the final organic black tea product. Bhutanese black tea production is a meticulous process that ensures natural essence of the tea is preserved. The stage includes withering, rolling, fermentation, drying, and roasting. Each production stage requires precision and proper handling. In withering, black tea leaves are left overnight to remove excess moisture so that they reach an optimal level for the next step rolling. Leaves are then rolled for four hours to shape them and release natural enzymes in them. Fermentation is a crucial step where leaves are stored in airtight condition allowing chemical reactions to develop tea's rich colour and aroma. Leaves are then roasted at 200°C for 20 minutes, followed by additional drying at 94°C to achieve the desired moisture balance. The quality of the tea mainly depends on the skills of workers and the machines.

Currently the Samcholing tea production unit in Bhutan have basic equip such as roasting, drying, and rolling machines but they still need for advanced tools like moisture checkers, shaking machines, and temperature monitors to ensure precision in fermentation and drying. The rolling machine they are using gives the issues in drying which affects the texture of the final product. Metal detector is recommended to critically control physical hazard. Lack of Standard Operating Procedures (SOPs) for quality control is another bottleneck in this stage. Despite having organic certifications and BICMA standards, the absence of quality assurance systems often results in batch inconsistencies. Implementing digital monitoring tools and standardized quality control training programs quality control can help improve the process and reduce defects like white–red discoloration and bitterness of the black tea.

3) Outbound Logistics

The packaged black tea is then distributed to both domestic and international markets and currently, Bhutanese back tea is available at local outlets,

Paro airports, and project offices like Queens Project Office (QPO) and Cottage and Small Industry (CSI). The health benefits of consuming black tea have spread among the locals compared to older times but still need to spread awareness. The international demand for organic and premium teas is high specially from countries like the USA, Germany, Canada, Russia, and the Netherlands. The main challenge is the high shipping costs to expand global reach. Structured online sales platforms, partnering with e–commerce platforms and creating cost–effective bulk shipping would highly benefit the small–scale farmers to expand the market globally. To enhance market penetration, partnership with global organic tea retailers by developing an affordable shipping partnership and establishing direct–to–consumer sales channels *via* an official website could boost revenue and visibility.

4) Marketing and Sales

The marketing of black tea in Bhutan still follows the traditional way, relying on community outreach, social media (Facebook, Instagram, TikTok), and television broadcasts (BBS Channel). While these methods are helpful to create awareness, they lack the global reach that is seen in other tea brands. One of the major challenges is differentiation. Although Bhutanese black tea has a unique, organic identity and it stands out from others tea, it is not well–positioned against competitors in the premium tea market. Bhutanese tea is still marketed through simple in–store promotions and word–of–mouth recommendations and need to emphasize more on packaging aesthetics, storytelling, branding, consumer attractive promotions, and consumer engagement. A stronger story telling can be revolve around Bhutanese black tea's cultural heritage, organic nature, and sustainable farming practices and especially Samcholing tea estate being the only women centric (https://samcholingteabhutan.com/). It is suggested to create specialty tea grades and explore premium markets for niche buyers.

Additionally, launching a dedicated website, collaborating with well–known influencers, and offering tea–tasting events internationally as a workshop or as an infotainment to both tourist and local people can help establish a more prominent identity in the global tea industry.

5) Service

Customer service in Bhutanese black tea offers a refund for the consumers in cases of expired products, and local shipping charges are covered by the producers. There are numerous areas needed to improve in customer services and needed to establish services like formal–after–sales services such as customer support, loyalty programs, and personalized recommendations. Introducing subscription–based tea deliveries, interactive brewing guides, and customer feedback programs would help in terms of customer retention and would add significant value. To create a more informed and loyal customer base, establishing an educational approach workshop specifically highlighting the health benefits of black tea would be a smart move.

3.2 Support Activities in the black tea value chain

1) Firm Infrastructure

Currently the Samcholing tea production facility in Trongsa, Bhutan is divided into three floors– the first floor for processing, the second floor for packaging and storage, and the last one for a canteen and outlet shop. While this structure is functional, it still needs modern touch. Upgrade processing plants, storage, and packaging facilities to meet international standards is in a Samcholing tea development plan. Further improvement spaces for GMP certification are required such as expanding storage facilities, integrating temperature–controlled environments, and investing more in ergonomics workplaces for the tea workers.

2) Human Resource Management

The 34 members consisting of only women are involved in tea production which is divided into three groups which cater to specific step– harvesting, processing, and quality control. The workers have received both online and hands–on training on the tea, but it is evident that they need more GMP hands–on training by tea experts from international countries and the opportunities for them to go outside to get more insights on big tea production facilities. Training programs specifically in fermentation techniques, machine handling, and international tea market trends will ensure the premium black tea quality.

3) Procurement

The Samcholing production facility depend on the imported packaging materials from India. It includes all the packaging materials like 60g tea

pouches and labeling stickers which add to production costs. Exploring and implementing alternatives to reduce dependency on imports and promoting sustainable, eco–friendly packaging solutions would be beneficial for the facility. It is suggested to use airtight and visually appealing packaging that complies with global standards

4) Technology development

The Bhutanese tea industry is slowly adopting modern technological improvements. New techniques have introduced since they receive the training from Thai experts from Chiang Mai, however they need to invest in automated moisture control, modern rolling machines to standardize tea leaf shapes and enhance quality, temperature and humidity–controlled fermentation units for uniform results, investment in modern drying equipment to achieve uniform moisture removal, controlled withering chambers for even and consistent moisture reduction, and quality testing machines to ensure production efficiency.

As much as Bhutanese black tea have a strong background and foundation in organic and traditional farming, but it also requires strategic improvements in logistics, quality control, and branding. Bhutan's black tea industry can compete globally by adopting advanced processing techniques, expanding e–commerce channels, and refining its brand positioning while also maintaining is unique and authentic identity.

4. Implied business model canvas for sustainable Bhutan black tea

The triple layered business model canvas originally designed by Joyce and Paquin (2016) is a tool to explore sustainability–based business model innovation which consists of extra two layers– an environmental layer (lifecycle perspective) and a social layer based on stakeholder perspective. All these three models working together can generate different types of values in economy, environment, and society. The production of organic black tea is in line with the development in all three aspects as shown in Figures 4.3 – 4.5 below.

ECONOMIC BUSINESS MODEL CANVAS

Partners
- Farmers, NGOs, local govt., tea buyers

Activities
- Organic farming, harvesting, processing, packaging

Resources
- Farmland, skilled labour, water, tools

Value Proposition
- Premium organic Bhutanese black tea

OGOP
ONE GEWOG ONE PRODUCT

Customer Relationship
- Direct trade, storytelling, ethical branding

Channels
- Local markets, online, eco-tourism centers

Customer Segments
- Health-conscious consumers, tourists, export markets

Costs
- Labour, transport, organic certification, packaging

Revenues
- Tea sales (retail/wholesale), tourism income

Figure 4.3 Samcholing tea economic layer

ENVIRONMENTAL LIFE CYCLE BUSINESS MODEL CANVAS

Supplies and Out-sourcing
- Local organic manure, eco-friendly tools

Production
- Hand-picked, low energy drying

Materials
- Organic leaves, bamboo baskets

Functional Value

Organic agriculture

End-of-Life
- Biodegradable packaging, compostable waste

Distribution
- Local delivery, low-carbon transport

Use Phase
- Health drink, sustainable lifestyle

Environmental Impacts
- Low emissions, zero chemical use

Environmental Benefits
- Promotes biodiversity, clean soil and water

Figure 4.4 Samcholing tea environmental life economic layer

SOCIAL STAKEHOLDER BUSINESS MODEL CANVAS

Local Communities
- Income generation, skill training

Governance
- Community-led, transparent decisions

Employees
- Fair wages, safe conditions

Social Value
- Women empowerment, youth employment

Societal Culture
- Preserves traditional farming methods

Scale of Outreach
- Trongsa, national, buyers

End-User
- Health-conscious tea lovers

Social Impacts
- Reduces rural-urban migration, builds pride

Social Benefits
- Community resilience, better livelihoods

Figure 4.5 Samcholing tea social stakeholder layer

An analysis of the Triple Layered Business Model Canvas for Bhutanese black tea reveals that the product delivers value across business, environmental, and social dimensions as follows:

Business dimension: Bhutanese black tea holds significant value as a national product under the OGOP (One Gewog One Product) initiative. It plays an important role in creating employment and generating income for local communities. Additionally, it supports the development of academic and research personnel to improve quality control systems for black tea and related products. These efforts align with the United Nations Sustainable Development Goal (SDG) 1: No Poverty, by contributing to poverty reduction.

Environmental dimension: The production of Bhutanese black tea follows organic practices, avoiding chemical inputs and utilizing natural materials. This helps to preserve the quality of soil, water, and air, ensuring a safe and healthy ecosystem. These practices support SDG 15: Life on Land, by promoting sustainable land use and environmental protection.

Social dimension: In the Samcholing community, tea production fosters cooperation and unity, while empowering women by equipping them with vocational skills, generating income, and creating opportunities for leadership. The community also serves as a learning hub for children and youth, and hosts study visits from both domestic and international guests. These contributions are in line with SDG 4: Quality Education and SDG 5: Gender Equality.

5. VRIO analysis for the sustainability of Bhutan tea in the global tea market

The VRIO framework is a strategic tool used to analyze an organization's internal resources and capabilities to determine their potential for sustainable competitive advantage.

Bhutan is situated in the eastern Himalayas and the tea industry that is gaining popularity which intertwines rich cultural heritage with sustainable agricultural practices. Samcholing tea production facility is in central which exemplify Bhutan's commitment to quality and community empowerment. This analysis includes the VRIO (Value, Rarity, Imitability, Organization) framework to assess the resources and capabilities of Bhutanese tea production, particularly focusing on Samcholing tea. Strategic recommendations are provided based on this evaluation to successfully penetrate and thrive in the competitive global tea market.

Tea in Bhutan offers a wide range of distinct value propositions. One of the main highlights of Samcholing tea production facility is that the tea is cultivated 1,800 meters above sea level which has a unique flavour profile. The cooperative focus is on organic cultivation and sustainability with a global shift towards health–conscious and environmentally aware consumers. It empowered the community especially the women by providing employment and opportunities to improve their livelihood which indefinitely contributes to socio–economic development. Samcholing tea production facility is started in the year 1950s when Bhutan's second king introduced tea from Darjeeling. The tea holds a huge significance, and it carries a rich historical legacy that adds to its allure. The location of the place and the climatic conditions are unique in its own which is different than others globally which imparts a unique characteristic to the tea having a high antioxidant property and chemical free. Tea is cultivated in only about 80 hectares, which enhances its rarity, appealing to niche markets which are looking for unique products.

Table 4.3 VRIO analysis of Bhutan tea production

VRIO analysis of Bhutan tea production			
Value	**Rarity**	**Imitability**	**Organization**
– Unique origin and distinctive flavour – Organic and sustainable practices – Community empowerment	– Historical significance – Geographical region – Limited production	– Harvesting techniques – Flavour characteristics	– Cooperative model – Capacity constraints – Market access
Strategic Recommendations for Global Market Entry • Enhancing production capacity by investing in production facilities with modern equipment and expanding cultivation areas and encouraging more farmers to join in boosting the economy and penetrate international markets • Strengthening brand identity by emphasizing more historical legacy and cultural impacts which can differentiate with other competitors, which makes it more appealing to consumers and introduce new tea like matcha or white tea for more diverse products • Expand market reach by participating in international trade fairs and using more social media platforms and e–commerce channels to create global awareness and break geographical barriers • Ensure quality and compliance by obtaining international certification and implement rigorous quality and control measures • Collaborations and partnerships with popular and established distributors can support market entry and other networks.			

Apart from Bhutan's tea possessing unique and rare attributes there are certain areas which are susceptible to imitation like cultivation techniques which is a blend of traditional, modern and organic which can be replicated anywhere with

sufficient knowledge and resources. Any countries can duplicate the flavour profile of Bhutanese tea using the advanced technology and practices. However, the Bhutan's unique environmental conditions and cultural heritage makes the tea distinctive product hard to fully imitate. The organizational structure of tea production has both strengths and areas for improvement. The Samcholing Tea Cooperative consisted of over 30 women managing all the activities–cultivation, processing, and marketing, fostering community engagement and ensuring equitable benefits. The market in domestic demand has no issues but the challenge is in international markets which require competitive marketing strategies and distribution networks. **Bhutanese** tea has a space for improvement and becomes a premium quality product if they enhance their production capabilities, strengthen brand identity, expand market reach globally, and collaborations with different partnerships and networks. It has significant potential to overcome current challenges and establish a significant presence within the country and globally.

Develop A QACCP Program for Black Tea Production

This study conducted at the Samcholing Tea Cooperative focuses on three key aspects: the cooperative members, the product characteristics, and the production process. The cooperative is composed of 32 female members, ranging in age from 25 to 65 years. Their primary responsibilities include harvesting tea leaves, applying organic fertilizers, processing the tea into black tea, packaging and labelling the final product, and promoting it at local festivals and OGOP retail outlets. The layout of Samcholing Tea Cooperative is shown in Figure 4.6. members have identified several pressing needs, such as receiving training on proper hygiene and food safety practices, improving the quality and safety of the finished product, acquiring machinery and production equipment, and gaining technical support from OGOP to implement international standard quality and safety systems. The black tea produced by the cooperative comprises dry, black–colored tea leaves free of visible mold. Laboratory analyses indicate that the tea contains 8.52% stem content (considered adulteration) For premium or export–quality teas, stem content is usually kept below 5% while standard commercial tea up to 8–10% may be tolerated to maintain flavor, aroma, and appearance. Bhutan black tea has 5.86% moisture, 1.26% caffeine, and no physical

contaminants (Table 4.4, Figure 4.7). It is packaged in 60–gram plastic zip–lock bags and should be stored in a dry, cool place away from direct light and moisture. For preparation, 10 grams of tea should be steeped in 150 milliliters of hot water at 90°C for 2–3 minutes before straining. The recommended consumer demographic spans ages 18 to 80. Distribution is handled *via* truck transport to OGOP shops located at Paro International Airport and in Thimphu.

Table 4.4 Laboratory analysis of black tea in comparison with International and Thailand standards

Quality	Bhutan black tea	International/ Thailand standards	Analytical Method
Stem content	8.52±0.12	10% max. a	Gravimetric method
Moisture	5.86±0.36	7% max. a	Gravimetric method
Total ash	5.26±0.22	4.0–8.0% max. a	Gravimetric method
Total polyphenols	6.78±0.24	9.0% max. a	HPLC
Total catechins	6.63±0.12	7.0% max a	HPLC
Caffeine	1.26±0.02	1.5% max b	HPLC
Total Plate Count	1 x10^2	1 x10^4 CFU/g b	Bacteriological Analytical Manual
Salmonella	Not found	Not found/25 g b	Bacteriological Analytical Manual
Staphylococcus aureus	Not found	<10/ 1 g b	Bacteriological Analytical Manual
Physical contaminants	Not found	Not found	Visual inspection

Note: a. International tea standard: ISO 3720:2011 Black tea — Definition and basic requirements

b. Thai FDA, Ministry of Public Health

c. Average ± standard deviation

The black tea production process at Samcholing begins with harvesting during the optimal growing season from March to October, when daytime temperatures in Trongsa range from 10–18°C. Leaves are handpicked in the morning, selecting young tea buds along with the first and second leaves–occasionally extending to the third and fourth. The leaves are collected in baskets, weighed immediately, and then allowed to wither overnight for approximately 16 hours to reduce moisture. Following this, the leaves are rolled for 4 hours, then left to wither again for an additional 2 hours until they turn reddish. The tea is then pan–roasted at 200°C for 20 minutes, with additional roasting applied depending on moisture content. A third withering phase of 2–3 hours follow. Next, the tea is fermented by sealing it in plastic bags for 48 hours. After fermentation, the leaves are dried in a dehydrator at 110°C for 30 minutes. The final product is sorted to remove foreign particles, measured into 60–gram portions, and packed into sealed bags for storage and distribution.

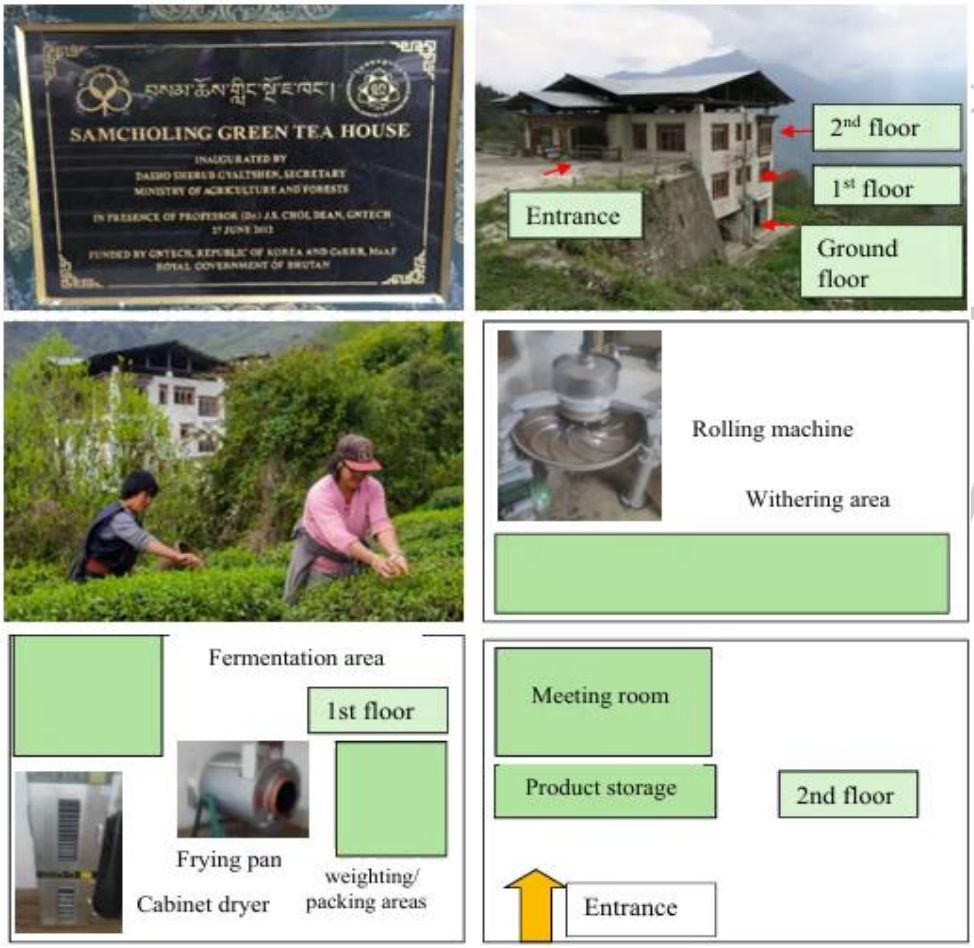


Figure 4.6 Layout of black tea production at the Samcholing Tea Cooperative, Bhutan

In conclusion, the production process used for Samcholing black tea is a modified version of the Orthodox method. It incorporates multiple rolling and withering stages, along with roasting to effectively reduce moisture and prevent mold formation prior to fermentation. The entire process, from harvesting to packaging, spans approximately three days. However, the use of mechanical withering–where air is blown to accelerate dehydration can shorten the drying time, enabling earlier fermentation. An overview of the complete process is provided in Figure 4.8.

Figure 4.7 Black tea (a) Bhutan (b) Chiang Mai (c) Chiang Rai showing liquor color, appearance of brewed leaves, and tea stem content

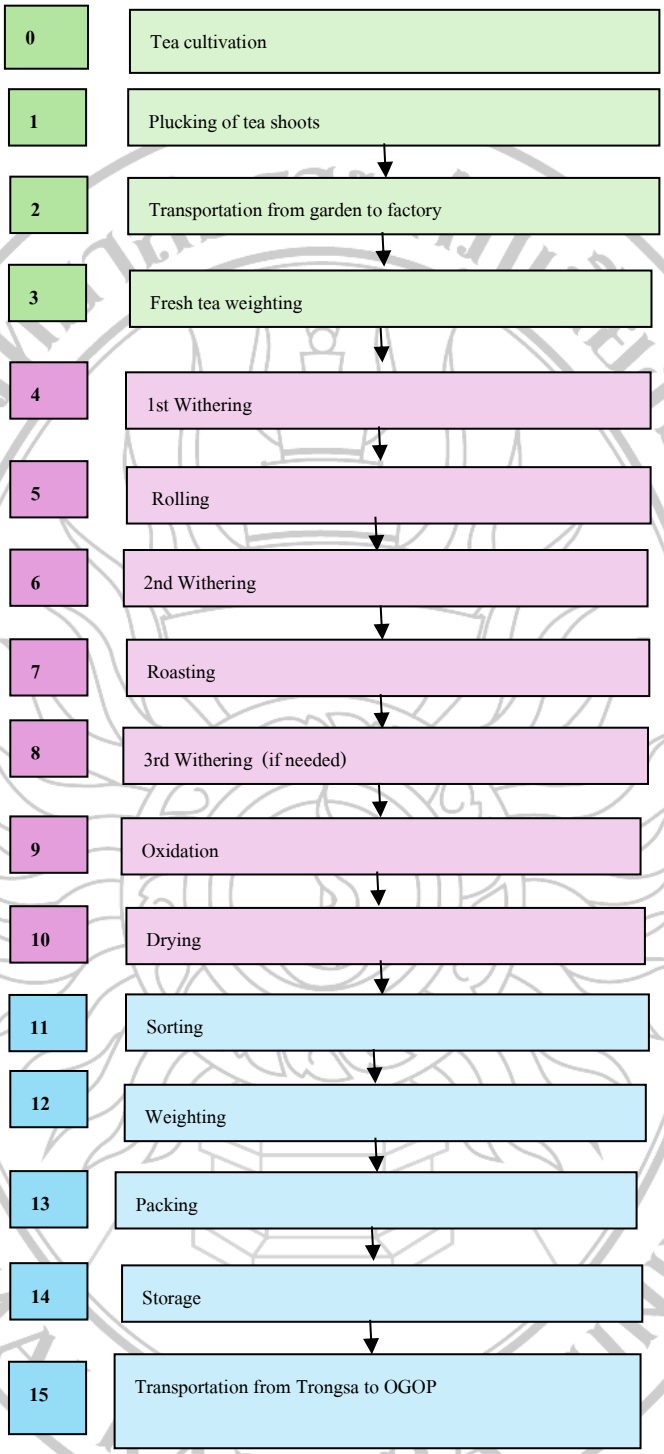


Figure 4.8 The 15 stages of Samcholing black tea processing

1. Process review and risk assessment systems

The Samcholing Tea Cooperative conducted a comprehensive review of its black tea production process (refer to Figure 4.8) by mapping the actual workflow from the collection of fresh tea leaves to the final packaging of dried tea. This review included the identification of control points across 15 distinct stages, incorporating three management systems: Good Manufacturing Practice (GMP), Hazard Analysis and Critical Control Points (HACCP), and Quality Analysis and Critical Control Points (QACCP). These were assessed using three key analytical tools: risk assessment matrices, the CCP decision tree, and the seven logical approach frameworks.

The classification of activities governed by GMP was primarily determined through risk assessments evaluating both health hazards and risks of product rejection due to quality concerns. Any activity with a severity (S) multiplied by probability (P) score of less than 8 was categorized under GHP control.

According to the standard operating procedures (SOPs) detailed in Table 4.5, tea cultivation must avoid genetically modified organisms and chemical inputs. Instead, natural methods such as the use of cow manure for fertilization are recommended. Tea should be cultivated in agroforestry environments to support biodiversity. SOPs also call for the implementation of pest surveillance and record–keeping protocols, utilizing Integrated Pest Management (IPM) strategies. Tea bushes should be irrigated and pruned to approximately 50 cm in height.

Harvesting practices must ensure the hygienic transport and handling of fresh leaves, including weighing, inspection of foreign matter, and removal of damaged leaves. Equipment used during harvest, such as baskets, bags, and weighing scales, must be regularly cleaned and calibrated annually, with proper documentation maintained. Designated handwashing facilities are required in both the tea garden and the processing building. Furthermore, annual training programs must be provided for the personnel involved in garden maintenance and harvesting, emphasizing hygiene protocols and fair labor practices. Waste management should also align with environmental conservation principles.

Table 4.5 GMP screening during Samcholing black tea processing from cultivation to delivery to OGOP shops

Step	Health hazards and quality rejection	Hazard Type	Severity level (*S*)	Probability level (*P*)	*S*×*P*	GHP (YES/NO)	SOP
0 Tea cultivation	– Pesticide residue, heavy metals	– Physical hazard	2	1	2	YES	Organic farming and certification
	– Plant disease and insect infections	– Biological hazard	2	2	4	YES	Organic farming and certification
1 Plucking tea shoots	– Gravel, snails	– Physical hazard	2	2	4	YES	Inspection of fresh tea leaves
	– Caterpillars, human pathogens	– Biological hazard	1	2	2	YES	Personal hygiene control/pest surveillance
	– Plunk only bud, 1st, 2nd and 3 red leaves affects liquor colour, taste, flavour, and aroma	– Sensory characteristics	3	3	9	**NO**	
2 Transportation from garden to factory	– Damage of the plucked leaves by excessive pressing	– Physical damage	1	1	1	YES	Inspection of fresh tea leaves Tea container cleaning

Table 4.5 (Cont.)

Step	Health hazards and quality rejection	Hazard Type	Severity level (S)	Probability level (P)	S×P	GHP (YES/NO)	SOP
0. Tea cultivation	– Pesticide residue, heavy metals	– Physical hazard	2	1	2	YES	Organic farming and certification
	– Plant disease and insect infections	– Biological hazard	2	2	4	YES	Organic farming and certification
1. Plucking tea shoots	– Gravel, snails – Caterpillars, human pathogens	– Physical hazard	2	2	4	YES	Inspection of fresh tea leaves
	– Plunk only bud, 1st, 2nd and 3 red leaves affects liquor colour, taste, flavour, and aroma	– Biological hazard	1	2	2	YES	Personal hygiene control/pest surveillance
		– Sensory characteristics	3	3	9	**NO**	
2. Transportation from garden to factory	– Damage of the plucked leaves by excessive pressing	– Physical damage	1	1	1	YES	Inspection of fresh tea leaves Tea container cleaning

Table 4.5 (Cont.)

Step	Health hazards and quality rejection	Hazard Type	Severity level (S)	Probability level (P)	S×P	GHP (YES/NO)	SOP
3. Fresh tea weighting	– Foreign objects e.g. dust, stone	– Physical hazard	1	2	2	YES	Inspection of fresh tea leaves
	– Human pathogens	– Biological hazard	1	2	2	YES	Tea container cleaning Personal hygiene control
4. 1st Withering	– Time and temperature are not suitable.to develop liquid colour, taste, flavour, aroma.	– Sensory characteristics	3	3	9	**NO**	Inspection of dried tea leaves
	– Foreign bodies (dust and stones)	– Physical hazard	2	2	4	YES	Floor/ceiling cleaning
	– Human pathogens and formation of mold due to inadequate drying	– Biological hazard	3	2	6	YES	Personal hygiene control

Table 4.5 (Cont.)

Step	Health hazards and quality rejection	Hazard Type	Severity level (S)	Probability level (P)	S×P	GHP (YES/NO)	SOP
5. Rolling	– Metallic contamination	– Physical hazard	2	2	4	YES	Inspection of dried tea leaves/ Machine cleaning Personal hygiene control
	– Microbial growth, human pathogens	– Biological hazard	3	2	6	YES	
	– Rolling techniques are not suitable.to develop liquid colour, taste, flavour, and aroma	– Sensory characteristics	3	3	9	**NO**	
6. 2nd Withering	– Time and temperature are not suitable to develop liquid colour, taste, flavour, and aroma.	– Sensory characteristics	3	3	9	**NO**	Inspection of dried tea leaves Floor/ceiling cleaning Personal hygiene control
	– Foreign bodies (dust)	– Physical hazard	2	2	4	YES	
	– Human pathogens	– Biological hazard	1	1	1	YES	

Table 4.5 (Cont.)

Step	Health hazards and quality rejection	Hazard Type	Severity level (S)	Probability level (P)	S×P	GHP (YES/NO)	SOP
7. Roasting (Pan Frying)	– Time and temperature are not suitable.to develop liquid colour, taste, flavour, and aroma.	– Sensory characteristics	3	3	9	**NO**	Inspection of dried tea leaves
	– Foreign bodies (dust)	– Physical hazard	2	1	2	YES	Machine cleaning
	– Human pathogens	– Biological hazard	2	1	2	YES	Personal hygiene control
8. 3rd Withering	– Time and temperature are not suitable.to develop liquid colour, taste, flavour, and aroma.	– Sensory characteristics	3	3	9	**NO**	Inspection of dried tea leaves
			2	2	4	YES	Floor/ceiling cleaning
	– Foreign bodies (dust)	– Physical hazard	1	1	1	YES	Personal hygiene control
	– Human pathogens	– Biological hazard					

Table 4.5 (Cont.)

Step	Health hazards and quality rejection	Hazard Type	Severity level (S)	Probability level (P)	S×P	GHP (YES/NO)	SOP
9. Oxidation	– Time, temperature, and relative humidity are not suitable to oxidize polyphenolic compounds.	– Sensory characteristics	4	3	12	**NO**	Inspection of dried tea leaves
	– High moisture of fermented tea, microbial growth, human pathogens	– Biological hazard	3	2	6	YES	Floor/ceiling cleaning
	– Gravel, sand, sharp wood splinters, heavy metal	– Physical hazard	2	2	4	YES	Inspection of fermented tea leaves

Table 4.5 (Cont.)

Step	Health hazards and quality rejection	Hazard Type	Severity level (S)	Probability level (P)	S×P	GHP (YES/NO)	SOP
10. Drying	– Time and temperature are not suitable to reduce moisture from tea leaves	– Mold growth	3	3	9	**NO**	Inspection of dried tea leaves
	– Foreign bodies (dust, iron rust)	– Physical hazard	2	2	4	YES	Machine cleaning
	– Human pathogens	– Biological hazard	2	2	4	YES	Personal hygiene control Pest control
11. Sorting	– Gravel, sand, sharp wood splinters, heavy metal Tea stalks	– Physical hazard	3	4	12	**NO**	Personal hygiene control
	– Human pathogens	– Adulteration – Biological hazard	2	2	4	YES	

Table 4.5 (Cont.)

Step	Health hazards and quality rejection	Hazard Type	Severity level (S)	Probability level (P)	S×P	GHP (YES/NO)	SOP
12. Weighting	– The weight does not match the label.	– Deceiving buyers	4	2	8	**NO**	
	– Human pathogens	– Biological hazard	1	1	1	YES	Personal hygiene control
13. Packing	– Packing not sealed properly or leaked,	– Increased moisture	3	2	6	YES	Inspection of the finished product
	– Incorrect or missing product information, such as the production date and expiration date	– Deceiving buyers	4	2	8	**NO**	Inspection of product labelling
	– Contamination by migration of packaging objects	– Physical hazard	1	1	1	YES	Recall procedure/consumer complaints
	– Human pathogens	– Biological hazard	2	2	4	YES	Inspection of the finished product Personal hygiene control

Table 4.5 (Cont.)

Step	Health hazards and quality rejection	Hazard Type	Severity level (S)	Probability level (P)	S×P	GHP (YES/NO)	SOP
14. Storage	– Proliferation of microorganisms	– Biological hazard	3	2	6	YES	Inspection of the finished product
15. Transportation from Trongsa to OGOP	– Damage of the packaging by excessive pressing	– Physical damage	2	2	4	YES	Inspection of the finished product Transportation control

Criteria: a score below indicates GHP, a non–significant risk that can be managed through SOPs.

Nationally, the Bhutan Food and Drug Authority (BFDA) mandates compliance with the Bhutan General Standard for Food Hygiene and the Mandatory Standard for Labelling of Prepackaged Foods (Bhutan Food and Drug Authority, 2025; Food Rules and Regulations of Bhutan, 2017), which set forth foundational guidelines for food safety and labeling. These regulations serve as a basis for specific operational compliance in the tea sector (Bhutan Food and Drug Authority, 2025).

Five critical stages in tea manufacturing—withering, rolling, roasting, fermenting, and drying–must adhere to GMP to minimize microbial contamination and the introduction of physical hazards.

Microbial risks: Several microbial organisms like bacteria (Salmonella spp., Staphylococcus aureus), fungi (Aspergillus spp., Penicillium) pose a risk of contamination. Contamination may originate from unclean equipment or personnel. Therefore, rigorous sanitation protocols must be observed across all processing zones, including fermentation and withering areas, rolling and drying machines, roasting pans, and storage trays. Surfaces like conveyor belts and floors must also be routinely cleaned.

Prevention of physical contaminants: Preventative measures should be implemented to avoid the introduction of foreign matters from equipment or tools. This includes maintaining usage logs, monitoring equipment conditions, performing regular maintenance, and using food–grade lubricants. Calibration of instruments measuring moisture, humidity, temperature, and time is also necessary.

Personnel must undergo hygiene training, and cleaning logs should be maintained for both infrastructure and equipment. Sanitary facilities, including restrooms and handwashing stations, must be fully functional, with access to clean water, hand soap, drying mechanisms, and waste disposal bins.

Post–processing steps, such as sorting, weighing, and packaging, must be conducted in well–lit environments using calibrated scales. Proper storage and transportation conditions are essential to prevent product deterioration.

2. Critical Control Points (CCPs) and Quality Control Points (QCPs) Identification

As illustrated in Table 4.9, the Seven Logical Approaches serve as a structured tool to differentiate between process steps that may pose significant safety risks–designated as Critical Control Points (CCPs)–and those that influence product quality–classified as Quality Control Points (QCPs). The analysis revealed that the primary physical hazards in Bhutanese black tea production include the presence of foreign objects such as gravel, metal fragments, large wood particles, and sharp tea stems. These contaminants can originate at various stages, from tea cultivation through to the drying process.

The sorting stage was identified as a critical intervention point for mitigating these physical hazards. According to the CCP decision tree, as recommended in the Codex Alimentarius guidelines, this step qualifies as a CCP because it plays a pivotal role in removing contaminants before tea leaves are weighed and packaged. The Samcholing production team is responsible for inspecting each production batch, which typically ranges between 10–20 kilograms. The inspection is carried out on a clean white surface under appropriate lighting conditions within the packaging facility. For larger batch sizes, a metal detector is employed to ensure thorough contaminant screening. This protocol guarantees that all tea products comply with safety standards before they enter distribution.

Meanwhile, Table 4.10 outlines the QCPs—eight key stages that have a direct impact on the sensory and quality attributes of Bhutanese black tea. Prior research has indicated that inadequate quality control at these points could result in substandard flavor, aroma, or misleading consumer information (Johannes et al., 2010). These QCPs are organized into three main groups: Tea Leaf Harvesting, Orthodox Processing, and Weighing and Packaging. Each category includes process steps that must be closely monitored to uphold consistent product quality.

Table 4.6 CCPs/QCPs screening during Samcholing black tea processing from cultivation to delivery to OGOP shops

Step	Health hazards and quality rejection	Form	Seven logical approaches							Total score	CCP (YES)	QCP (Yes/No)
			A	B	C	D	E	F	G			
Plucking tea shoots	Plunk only bud, 1st, 2nd and 3rd leaves affects liquid colour, taste, flavour, and aroma.	Sensory characteristics	1	2	2	2	1	1	1	10	NO	YES
Withering	Time and temperature are not suitable.to develop liquid colour, taste, flavour, aroma.	Sensory characteristics	1	3	1	2	3	1	3	14	NO	YES
Rolling	Rolling techniques are not suitable.to develop liquid colour, taste, flavour, and aroma.	Sensory characteristics	1	3	1	2	1	1	3	12	NO	YES
Roasting	Time and temperature are not suitable.to develop liquid colour, taste, flavour, and aroma.	Sensory characteristics	1	2	1	2	1	1	3	11	NO	YES

Table 4.6 (Cont.)

Step	Health hazards and quality rejection	Form	Seven logical approaches							Total score	CCP (YES)	QCP (Yes/No)
			A	B	C	D	E	F	G			
Fermentation	Time, temperature, and relative humidity are not suitable to oxidize polyphenolic compounds.		1	2	3	3	3	1	2	15	NO	YES
Drying	Time and temperature are not suitable for reducing moisture from tea leaves.	Sensory characteristics	1	2	3	3	3	1	3	16	NO	YES
Sorting	Gravel, sand, sharp wood splinters, heavy metal Tea stalks	Physical hazard Adulteration	3	3	3	3	3	3	1	19	YES	NO
Weighting	The weight does not match the label.	Deceiving buyers	1	3	3	1	3	1	1	13	NO	YES
Packing	Incorrect or missing product information, such as the production date and expiration date	Deceiving buyers	1	3	3	1	2	1	1	12	NO	YES

Criteria: When the total score is below 17, the issue is managed through QCPs under the QACCP framework.

Table 4.7 QCPs/CCPs plan for Samcholing black tea processing, Trongsa, Bhutan

Step	Quality	Critical limit	Monitoring procedure				Correction	Corrective action
			What	When	How	Who		
Plucking tea shoots	Sensory aspect	Plunk Bud and 1^{st}–3^{rd} leaves	Tea leaf picking	8.00 am–12.00 pm March to October	Hand–picking	Harvesting team	Visual inspection	Sorting out, Instructions to Harvesting team
Withering	Sensory aspect	14–16 hrs./ 15–18 ºC	Temp./time record	5–hour interval	Use a thermocouple/ a digital watch	Processing team	Withering conditions	Adjust time/temp.
Rolling	Sensory aspect	4 hrs./ 45 rpm/min. 15–22 ºC	Time record	2–hour interval	Use a digital watch	Processing team	Rolling conditions	Adjust time/ Rolling time/temp.

Table 4.7 (Cont.)

Step	Quality	Critical limit	Monitoring procedure				Correction	Corrective action
			What	When	How	Who		
Roasting	Sensory aspect	200ºC/ 20 mins	Temp./time record	a batch interval	Use a thermocouple/ a digital watch	Processing team	Roasting conditions	Adjust time/ Rolling time/temp.
Oxidation	Sensory aspect	2 days/ 25 ºC/ 95% RH No air leakage/ No mold	Time/temp./ RH record	every hour	Use a digital watch/ a thermocouple/ an RH probe Visual inspection	Processing team	Oxidation conditions	Adjust time /temp/RH
Drying	Sensory aspect Moisture/caffeine/ Microbial standard	110ºC/ 30 mins.	Temp./time record	a batch interval	Use a thermocouple/ a digital watch	Processing team	Drying condition Visual inspection	Adjust time/temp Re–dry, sorting out

Table 4.7 (Cont.)

Step	Quality	Critical limit	Monitoring procedure				Correction	Corrective action
			What	When	How	Who		
Weighting	Food labelling standard	60+1 gram	Dried black tea weighting	Periodic inspection at each bag	Use a 1–digit digital balance	QC team	Weigh and repackage	Check the weight and calibrate the scale every year.
Packing	Food packaging Standard	No leakage	Dried black tea packing	Periodic inspection at each bag	Turning the bag upside down	QC team	Test by flipping the packaging to check for leaks	Inspect the packaging, such as for leakage, and the labelling before use

Table 4.7 (Cont.)

Step	Quality	Critical limit	Monitoring procedure				Correction	Corrective action
			What	When	How	Who		
Sorting	Physical hazard	No metal, gravel	Separate foreign contaminants	Periodic inspection at each batch	Spread the dried black tea leaves on a white table and then sort them Use a magnetic bar	QC team	Visual inspection/ metal detection	Sorting out, instructions to processing team

QCPs in Harvesting Tea Leaf

Tea leaf harvesting represents a foundational stage in the production of black tea and has a direct influence on its sensory characteristics, particularly taste and aroma. The quality of tea leaves is affected by several agronomic and environmental factors, including cultivar type, altitude, soil conditions, water availability, temperature, and harvesting season.

Empirical studies (M. Aaqil, et al., 2023; M. M. Rana et al, 2022; J. Zhu, et al., 2025) have shown that levels of caffeine, theaflavins, and thearubigins—key compounds that contribute to black tea's distinct flavor and aroma—are highest in the bud and first two young leaves. These levels decline progressively in older leaves (third to fifth leaves). Furthermore, the timing of harvest rounds significantly affects these compounds. Caffeine content peaks during a 7–day plucking interval, while extending the interval to 11 days results in a slight decrease in caffeine but a corresponding increase in theaflavins and thearubigins, which enhance flavor complexity.

To reduce bitterness and preserve the aromatic profile of black tea from Samcholing, it is advisable to harvest only the bud and the first to third leaves. Additionally, a harvesting interval of 9 to 11 days is recommended, ideally conducted through manual hand–plucking at ambient temperatures between 18°C and 24°C during the May to August period. This approach minimizes physical damage and wilting of the leaves.

A QCP should be implemented at this stage by conducting random inspections of the harvested material to ensure the exclusion of older, lower–quality leaves. If non–compliant leaves are detected, they must be discarded, and the harvesting team should undergo corrective training. This training should emphasize sensory differentiation between high– and low–quality tea leaves in terms of aroma and taste, thereby reinforcing the Samcholing Cooperative's harvesting standards.

1. QCPs in Orthodox tea processing

The Orthodox method used by the Samcholing Tea Cooperative includes several processing stages, each of which significantly affects the chemical composition, aroma, flavor, and visual appeal of black tea. These stages are monitored

as Quality Control Points (QCPs) to ensure product consistency and consumer satisfaction.

2. Withering

Withering reduces the moisture content of fresh tea leaves from approximately 70–80% to 60–70% and generally takes 12–14 hours. This stage is critical in enhancing the tea's aroma and flavor by stimulating the formation of volatile compounds such as geraniol and linalool. The optimal temperature is around 22°C, with a maximum recommended duration of 20 hours (Dhanakumar, 2022; Tomlins & Mashingiadze, 1997). Exceeding this timeframe may reduce polyphenol oxidase (PPO) activity, leading to brittle leaves and reduced fermentation potential. To expedite moisture removal, techniques such as air–blowing and manual turning of leaves are employed (Kristiningrum, et al., 2023; Lokunarangodage, et al., 2016). A designated QCP requires continuous monitoring and documentation of both temperature and duration to avoid deviations that compromise product quality. Research also suggests that gentle agitation and exposure to yellow light can improve the development of aroma during this stage (Ai, et al., 2025).

3. Rolling

Rolling disrupts the cellular structure of the tea leaves, facilitating the release of PPO, peroxidase, and catechins–key enzymes and compounds involved in the formation of theaflavins and thearubigins during oxidation. Theaflavins contribute to brightness and briskness, while thearubigins provide body and color. The ideal rolling temperature ranges from 10°C to 25°C. The first rolling typically lasts 4 hours, followed by a second, shorter rolling of 2 hours at 45 rotations per minute. Studies confirm that two rounds of rolling significantly enhance the extraction of bioactive compounds (Q. Chen et al., 2023; P. Gouws et al., 2014). As a QCP, the production team must consistently monitor and record rolling speed, time, and temperature to preserve desired sensory attributes.

4. Roasting (Pan Fixation)

The pan–firing step is employed to quickly lower moisture levels and enhance the tea's flavor and aroma. In Samcholing's process, roasting is performed at a higher–than–average temperature of 200°C for 20 minutes (compared to the typical 160–180°C range) (Tea & Travel, 2023; Shu–Yen Lin et al, 2021). This elevated

temperature rapidly reduces residual moisture–often still high after withering–thereby minimizing the risk of mold growth during oxidation. Strict control of temperature and time is essential, as overexposure can inhibit PPO enzyme activity, resulting in suboptimal oxidation outcomes.

5. Oxidation

Oxidation is a pivotal stage that shapes the final flavor, color, and aroma profile of black tea. The process is carried out at 20–30°C for 30–120 minutes, under controlled humidity (85% and adequate oxygen levels. Proper oxidation reduces the tea's pH from 5.5 to around 4.5–4.8 (Guangneng Li, et al, 2024; Thomas Muthumani & Ravipati Sandeep Kumar, 2007). Maintaining hygiene and environmental conditions during this stage is crucial to preventing spoilage. Over–fermentation can result in a dull color and loss of theaflavins, negatively impacting sensory quality.

6. Drying

Drying reduces the final moisture content of black tea to below 8%, which is necessary to prevent spoilage during storage. Research shows that moisture levels above 11% (water activity > 0.61) can support microbial growth, including Escherichia coli, rendering the product unsafe (Federica, Olga, Jacopo, Adriana, Armando, et al, 2018). In Samcholing, drying is conducted at 110°C (within the 90–140°C range) for 25–30 minutes. The drying temperature is controlled through direct measurement of incoming air in the dehydrator. The QCP team ensures this step is consistently monitored to maintain product safety and quality.

In summary, the Orthodox processing stages involve multiple quality–critical parameters—such as time, temperature, humidity, and mechanical operations—that affect the chemical and sensory properties of black tea. These parameters are overseen by the QACCP team in parallel with HACCP and GHP frameworks to uphold Samcholing’s quality standards.

QCPs in Weighing, Packaging, and Labelling

In addition to maintaining high standards throughout cultivation and processing, the final stages of weighing, packaging, and labelling are also governed by Quality Control Points (QCPs), as these directly influence consumer trust, regulatory compliance, and marketability.

Proper packaging safeguards the sensory and physical quality of black tea, ensuring that attributes such as aroma, flavor, and texture are preserved during storage and transportation. Packaging materials must be clean, sealed, and designed to prevent exposure to moisture, light, or air, which can degrade the product.

In accordance with the Bhutan Mandatory Standard for Labelling of Prepackaged Food, packaging must also display legally required information, including:

1. Product name
2. Ingredient list
3. Net weight
4. Storage instructions
5. Name and address of the producer
6. Manufacturing and expiration dates
7. Instructions for use
8. Contact information for consumer inquiries

Net weight accuracy is especially important; discrepancies between labelled and actual weight can lead to consumer complaints or regulatory action. Therefore, weighing equipment must be regularly calibrated, and final packaging should undergo random inspections to confirm compliance.

Moreover, labels can serve as powerful communication tools by conveying the unique value of the product. To support international marketing efforts, health benefit claims and product storytelling should be backed by credible sources, such as scientific literature (Khan & Muktar, 2018; Yan, et al, 2020). These strategies help position Bhutanese organic black tea as a premium product in global markets.

Any issues identified during final inspection–whether related to incorrect weights, defective packaging, or labelling omissions–must be reported to the QACCP team. Corrective actions should be communicated clearly to the production unit before distribution to wholesalers or direct consumers.

In conclusion, the weighing, packaging, and labelling phase is not merely a logistical endpoint but a critical area that bridges production and consumer satisfaction. Through QCP monitoring and adherence to national food labelling standards, the integrity and competitiveness of Samcholing black tea can be effectively maintained.

CHAPTER 5

CONCLUSION, DISCUSSION, LIMITATIONS AND RECOMMENDATIONS

This chapter presents a summary overview of chapter research findings, and discussion was carried out according to the research objectives. Implications, limitations and recommendations are included for future development of Bhutan tea products.

Conclusions

This research is done to explore how the use of Quality Analysis and Critical Control Points (QACCPs) could help make the change the value chain and productivity of organic black tea in Bhutan. The study aimed to analyze the existing practice, find out the main challenges faced by the tea producers in Bhutan and it can apply to all other products in Bhutan, and propose solutions to make the quality better in tea more than present and make more competitive and premium in the market. The main goal was to build a QACCP model that fits Bhutan's conditions and use it to strengthen every step involved in the tea value chain.

Several key findings came out of the study from the information collected in Bhutan and Thailand.

First, Bhutan has a limitless potential for organic black tea production due to its natural environment, clean air, organic farming, and national goal of becoming a 100% organic nation. Tea farming is part of culture and tradition in life of Bhutan people and places like Trongsa, where communities such as the Samcholing Tea Cooperative are already involved in growing and processing organic tea. However, these tea producers face many challenges and difficulties, which one of the major issues is that the farmers and cooperatives do not have modern machines and equipment. This issue makes it hard for them to maintain the consistent same quality

in every batch of tea. They often operate everything by hand, which is tiring, slow, and sometimes leads to mistakes in the process.

Second, the research found that many tea producers do not have formal training in quality assurance systems like the new concept like QACCP. Farmers are aware that quality of tea matters, but they do not follow a step–by–step method to control it which, because of this, leads to inconsistency in the tea's flavor, aroma, and appearance. Lack of proper systems in order makes it harder for them to meet international standards, which is necessary if they want to sell tea to other countries.

When the two scenarios, situation in Bhutan was compared to Thailand – especially in Chiang Mai and Chiang Rai– it became clear that Thailand has made better progress in using both traditional and modern methods together. To give an example, Raming Tea Estate and the Doi Tung Development Project have invested in equipment and training to improve their tea quality. Those two–tea production facility have strong quality control systems, which include standard procedures at each stage of tea processing. These practices help them to produce tea that meets international standards, and their products are more attractive to both domestic and foreign buyers. Drawing this comparison helped identify what Bhutan is lacking and the areas for further improvement. By learning and implementing Thailand's approach, Bhutan can evolve better than now. The key is to develop a quality system that is not too complex but still effective for small–scale farmers. This includes identifying important steps like withering, rolling, fermentation, and drying, and ensuring that farmers understand clearly how to control these stages to maintain tea quality.

Lastly, the research found that the value chain in Bhutan's tea industry is still underdeveloped. There are many gaps starting from the farm to the final scale. For example, poor packaging, weak marketing strategies, and lack of access to export markets all minimize the value that producers can earn. Using QACCP as a guide and redesigning a value chain with proper planning, then the farmers and tea cooperatives can add more value to their products and increase their income.

The findings of this study show that Bhutan's organic black tea sector has many potentials and strengths – such as a clean environment and strong community support – but also faces many unavoidable challenges. These include low technical knowledge, lack of infrastructure, limited quality control systems, and difficulties in

getting organic certification. By applying a QACCP system, redesigning the value chain, and learning from successful models in Thailand, Bhutan can make upgrade its tea production and become more competitive in both local and international markets.

Discussions

This study provides important contributions to different areas such as academics, practical tea production, and policy making. It solely focuses on how Bhutan can improve its organic black tea sector using the QACCP method and redesigning the current value chain. The research looks at both the problems and solutions for small–scale tea producers and offers ideas that can help them move forward for better future.

1. Academic contribution

This research provides and adds new information to the academic field of agricultural management, food enterprise, and quality control. There are handful and not many detailed studies about QACCP being used in organic tea production, espeially in Bhutan. This detailed study becomes a valuable reference for future students and researchers who are interested in food quality, value chains, or organic agriculture. By applying this system in real–world, it will show a system like QACCP can be used not only for food safety but also for improving product quality and market value.

2. Practical contribution to farmers and tea producers

This study gives a clear example of how QACCP can be developed and used by tea producers in Bhutan. it is practical because it is based on real challenges faced by local farmers – such as lack of training, tool, machines, and certification. The system is simple and can be customized for small cooperatives like the Samcholing Tea Cooperative. The study also shows how improving small steps can make a huge difference in overall quality – like in cooperating new standards how tea is dried or rolled. This ultimately help farmers to get the full ideas about the importance of following proper steps and monitoring quality at each point in the production chain.

3. Policy and development contribution

This research provides helpful suggestions for the Bhutanese government, agricultural offices, and development organizations. It identifies the gaps in infrastructure, training, and certification support. The findings show the need for programs that support organic farmers not only with funding but also with technical training, equipment, skills upgrade, and market access. The study supports Bhutan's vision of becoming a 100% organic nation and provides clear steps that government bodies and NGOs can take to support that mission through tea industry.

In conclusion, this research is very useful and will come handy for future researchers, farmers, and policymakers. It introduces the idea of QACCP in a new area and offers a real time solutions that producers can apply. It also gives clear advice to decision–makers on how to support the organic tea sector in Bhutan. This research hopes to contribute in a small way to long–term success and sustainability of Bhutan's organic black tea industry by combining research with practical action.

Implications

The findings of this research have several vital implications for different areas and groups involved in Bhutan's organic black tea sector. These different groups include tea producers, the economy, and the sustainable development. Each of these areas will be benefited if implemented the QACCP system and improved the value chain.

1. Benefits for tea producers

The direct implication of this research is mainly for the farmers and cooperatives who grow and process any kinds of tea. Many if the tea producers face challenges in areas like poor–quality control, lack of proper equipment, and limited knowledge about international standards. This study shows that using a system like QACCP can help tea farmers improve the way they work to produce best quality end result. QACCP system teach producers to have a better control at each stage of tea production starting from harvesting to packaging which helps tea stay consistent in quality, aroma, taste, and appearance. This will help farmers gain more trust from consumers and buyers and even access new, higher–paying markets which will result in better income for farmers, stronger cooperatives, and more opportunities to grow

their businesses. The study also portrays how important it is for producers to receive training and support to apply QACCP correctly, so they can monitor their own production and correct the issues when they arise.

2. For the Bhutanese economy

The tea industry can play a significant role in Bhutan's economy. It can help make Bhutanese tea more competitive in both local and international markets by improving the quality of organic black tea and strengthening its value chain. If the tea meets international standards, there will be increasing demand from countries and consumers that are looking for distinct and unique, clean, sustainable, and high–quality products.

With more demand means more exports of Bhutanese organic black tea, which will bring in foreign exchange, reduce dependence on imports, and create more job opportunities, especially in rural areas. The tea industry can also motivate and give pushing factors for growth in related areas such as packaging, transportation, branding, and tourism. "Tea Tourism" could be one of the examples to become a part of Bhutan's eco–tourism sector by allowing visitors to see organic tea farms and taste local premium products.

3. For Sustainable development

This study also has important implications to fulfill Bhutan's national goal of being the world's first 100% organic country. The QACCP framework supports this goal by helping tea farmers follow organic farming methods more effectively while maintaining high quality. This ensures that the whole process starting from soil care and organic inputs to the final product follows environmentally friendly practices. QACCP help to protect the environment by reducing chemical use and managing waste properly. This aligns perfectly with Bhutan's values of Gross National Happiness (GNH), which focus on balance between economic development and environmental protection. The findings can be useful for other organic crops and not only tea. If QACCP works well with black tea, the similar systems can be designed for organic vegetables, fruits, or herbal products. QACCP can be a useful model to promote agriculture across Bhutan.

Limitations

Although this research focus and aim to show how the QACCP system can be used to enhance the value chain of organic black tea in Bhutan, it is also important to acknowledge certain limitations. Some limitations may have affected the depth and flow of research findings but they also provide areas for improvement in future studies.

1. Limited Access to Participants in Bhutan

It is not easy to meet in real life to talk with tea farmers working in Samcholing Tea Estate due to distance, time, and logistics challenges which may have affected in collecting in depth and complete information. Heavy reliance on online interviews with farmers is challenging with frequent slow internet connectivity and limited time. This may have affected the quality of the information.

2. Geographical Limitations

The study is mainly on two countries in specific areas– Trongsa in Bhutan, and Chiang Mai and Chiang Rai in Thailand. Those areas have their own reputation and have important tea producing regions however the results may vary and not fully represent the situation in all other tea–growing sectors areas in both countries. For example, other places may have their own different challenges, practices and culture that were not shown in this research.

3. Time Constraints

The study was required to be completed within a specified timeframe, as the scholarship duration was limited to two years. Conducting the research proved challenging due to constraints imposed by the academic calendar and associated deadlines. Additionally, the fluctuating weather conditions in Chiang Mai–particularly during the rainy season–further complicated efforts to manage time effectively.

Recommendations

The findings of this study offer several key recommendations aimed at enhancing the quality and value chain of organic black tea in Bhutan. These recommendations are primarily intended for farmers, tea cooperatives, policymakers, and future researchers. The overarching goal is to ensure that Bhutan's tea sector can

grow in a sustainable and competitive manner by adopting the QACCP system and implementing best practices across the production and supply chain.

1. For Tea Cooperatives and Farmers

Farmers and cooperatives could introduce simple QACCP system in their tea production process. The system means identifying key control points such as harvesting, withering, rolling, and drying, and setting quality standard for each step. These systems can be simple but must be consistent and followed regularly to obtain the best outcomes. Most farmers have a knowledge gap in quality control and modern processing techniques which require regular training on topics in proper withering techniques, hygiene practices, moisture control, and quality assessment. Such training can be initiated by agricultural offices or NGOs. Working in groups makes everything easier in terms of applying for organic certification and receiving support from government or international organizations, therefore producers are encouraged to form a group to share resources, improve bargaining power, and reduce costs. Tea producers should invest in eco–friendly and attractive packaging and must develop a unique and clear brand identity that shows Bhutan's organic image because a good packaging is important to maintain the quality of tea and attract more buyers from all over the world. This will make the products stand out in both local and international markets.

2. For Government and Policymakers

Financial support from the government would be a great help to small–scale organic tea producers. The money can be used to purchase machines, rolling equipment, and packaging materials. National QACCP training program could be developed to teach farmers and cooperatives how to apply QACCP in organic farming through workshops and practical sessions. The government could help the farmers by simplifying the process of getting certification and reducing fees for small producers. Some places in Bhutan need better infrastructure like better road, storage facilities, and transport systems to reduce delays and preserve tea quality. The government should also promote Bhutanese tea in international trade fairs and support online selling platforms to reach global consumers.

3. For Future Researchers

Future researchers with an interest in the system could conduct further studies to evaluate its long–term effects on tea quality and farmers' income. Assessing the impact of QACCP over an extended period would provide valuable evidence of its sustained benefits while also identifying any practical challenges that may arise during implementation. Given that QACCP is applicable to a range of products, future studies could also explore its effectiveness in other organic crops such as ginger, turmeric, and vegetables. Such research would contribute to expanding the application of quality assurance systems within Bhutan's broader organic farming sector and support the development of more resilient and higher–quality agricultural value chains.

There remains significant scope for further research in related areas, beyond the insights this study has provided into the development of the organic black tea value chain in Bhutan. Future researchers, particularly those with an interest in sustainable agriculture and value chain development, could undertake more in–depth studies to deepen understanding and support the growth of sustainable tea industries in Bhutan and other comparable countries.

One promising direction for future research is an assessment of the long–term impacts of QACCP (Quality Assurance Critical Control Points) implementation. This could include measuring changes in product quality, farmers' income levels, market access, and overall production efficiency over an extended period. Additionally, further studies could explore consumer perceptions of Bhutanese organic tea in both domestic and international markets. Such research might focus on factors influencing purchasing decisions, including packaging, labeling, certifications, pricing, and the cultural narratives associated with the product.

Another important area of investigation could be a cost–benefit analysis of QACCP systems for smallholder farmers. This would involve evaluating the expenses related to training, equipment, and certification in comparison to the benefits derived from improved product quality and potentially higher market prices.

Given that the Samcholing Tea Estate is led by women, future research could explore the empowerment of women through tea farming, specifically examining their roles in quality management, leadership, and community development. While this study compared Bhutan and Thailand, subsequent research could broaden

the scope by including other tea–producing countries such as India, Vietnam, or Sri Lanka. Such comparative analysis would offer a more comprehensive understanding of best practices in organic tea production and global quality assurance systems. Additionally, future studies could investigate the potential of digital tools—such as mobile applications for farmers, moisture sensors, and blockchain technologies for traceability–to support the implementation of QACCP (Quality Assurance Critical Control Points) and enhance quality across the tea value chain.

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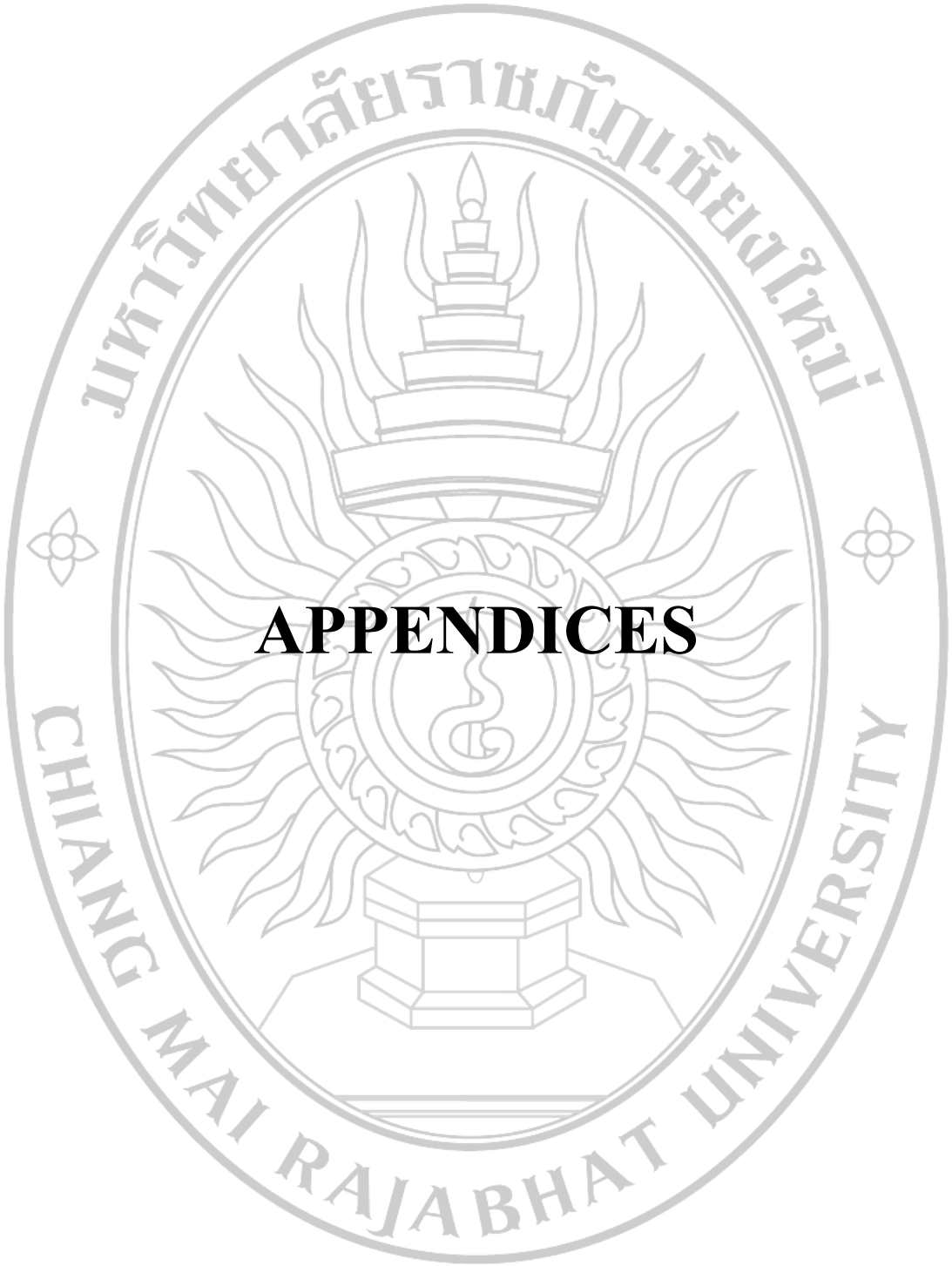


APPENDICES

Appendix A

Interview Questions

For organic tea producers, tea processing facilities, and government regulatory bodies

1. Supply chain

1.1 Explain the production of black tea, from tea cultivar selection, planting and care, harvesting, black tea production, to transportation to various markets

1.2 What are the obstacles/bottle neck in black tea production today in terms of raw materials, production skills, location, machinery, market distribution, and consumer preferences in national and foreign markets?

1.3 Do you use any internal standards or other standards to ensure the safety and quality of black tea? What standards do you apply?

1.4 Do you think the current production of black tea is sufficient in quantity, meets quality standards, and can be delivered consistently, with minimal losses or returns? If not, what are the problems?

2. Value chain

2.1 How does the management of the tea leaf sources, such as the choice of tea cultivar, soil maintenance, irrigation, pest control, harvesting season, and harvesting methods, affect the quality of tea leaves before processing?

2.2 What are the key steps in the black tea production process? Which steps require special control to ensure the tea is of high quality?

2.3 Who are the consumers of black tea, and what are the reasons they prefer black tea over other types of tea? How is the product transported to consumers? Where are the points of sale for the product?

2.4 What are the marketing channels for black tea, both in–store and online? How is product information (sources, production process, shelf life, certifications, and brewing methods) communicated to consumers? How is the difference created for black tea from other tea products?

2.5 How are after–sales services typically handled in areas such as customer contact, customer retention, acquiring new customers, and handling product issues (like quality and pricing)?

2.6 Where are the tea leaves sourced from? What about packaging and labeling? What is the structure of the production facility, the machinery used, and what are the new market opportunities? Does the product have external certification from any regulatory bodies? Please explain.

2.7 Has the group applied production techniques, machinery use, quality control systems, research studies, or research utilization to develop black tea with good quality?

2.8 How many members are in the group? How is the tea production process divided among the members? Is the labor force sufficient? Is there job rotation? What skills are necessary for each role in the tea production process? Are there training programs to enhance knowledge and skills within the group or from external organizations? What kind of training is provided?

3. Production and Quality Control (Bhutan and Thailand)

3.1 What makes Bhutanese/Thai black tea special, and what is the production process before it is ready to drink?

3.2 What Determines the Quality of Bhutanese/Thai Black Tea? Which Steps are Quality Control Implemented in the Group? Consequences of Not Controlling Quality

3.3 Does the group implement basic procedures for production and quality control of black tea? Is there a clear production flowchart? Are there personnel responsible for production and quality control?

3.4 Are their basic quality support programs, such as GMP (Good Manufacturing Practices)? Are there established or referenced quality standards for black tea? Is the quality of the black tea regularly tested and are the test results reported?

4. QACCP and HACCP (Bhutan)

4.1 What do you think determines the quality of black tea? (Physical – no adulteration with tea stems, gravel, chemicals – moisture, color, caffeine, catechins,

polyphenol compounds, antioxidant activity, microbiological – mold, or sensory – color, aroma, taste, smoothness)

4.2 What do you think determines the safety of black tea? (Physical – no adulteration with, gravel, chemicals – pesticide)

4.3 Does the group implement the following actions?

Define critical quality/hazard control points

Define quality/hazard indicators

Monitor quality/hazard indicators

Implement corrective actions to bring production back to quality standards and prevent hazards? If yes, how are they carried out?

4.4 Does the group maintain documentation to support quality control? For example:

Standard Operating Procedures (SOPs) for production

Standard Operating Procedures (SOPs) for quality and hazard control

Forms for quality/hazard control records

5. Using Interview Results for Developing Black Tea Production in Bhutan

What are the expectations for the researcher in using the interview results to develop black tea production in Bhutan?

5.1 Expectations regarding the production process

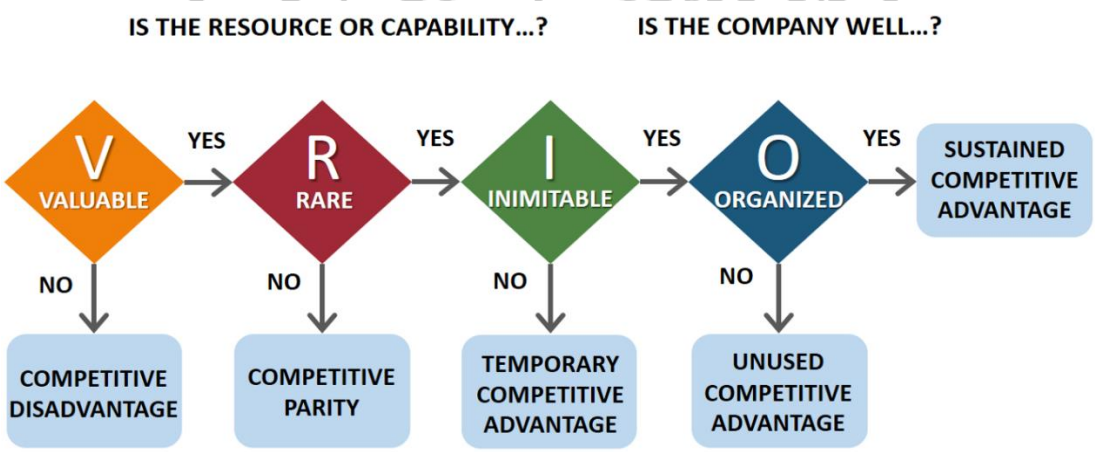
5.2 Expectations regarding marketing and sales

5.2 Expectations regarding the development of skills and knowledge of personnel

5.4 Expectations regarding sustainable development

Appendix B

VRIO Screening Questions



1. Is black tea **VALUABLE**? Does it provide value to the organization?

   Yes (competitive advantage) No (competitive disadvantage)

2. Is black tea **RARE**? Is it not possessed by many other organizations?

   No (competitive parity)

3. Is black tea difficult to **IMITATE**?

   No (temporary competitive advantage)

4. Is black tea product organized to capture the value?

   Yes (sustained competitive advantage) No (unused competitive advantage)

Applying VRIO analysis to organic black tea productivity in Trongsa, Bhutan.

STEP 1: identify key resources and capabilities.

- Soil quality and climate conditions
- Organic farming techniques
- Tea processing technology
- Knowledge and expertise of local farmer

- Brand reputation and market presence
- Access to sustainable farming resources.

STEP 2: analyze above each points using VRIO.

- VALUE (if unique soil quality in Bhutan provides superior tea flavour)
- RARITY (if the organic farming techniques used are not widely practiced in another region)
- IMITABILITY (complexity of organic certification processes and the uniqueness of the local knowledge)
- ORGANIZATION (check if the organization like tea farms or processing facilities is structured to fully leverage the above resources examples look at the efficiency of supply chain, effectiveness of training program for farmers, and the integration of sustainable practices)

STEP 3: data collection and then analysis.

- Data collection (through interviews with farmers, surveys, field observations, articles….)
- Analysis (use the data collected to analyze the capability against VRIO criteria. develop a scoring system to evaluate each)

STEP 4: summarize the findings and make recommendations.

- Summarize by highlighting which resources provide a competitive advantage in organic tea production.
- Identify gaps or weaknesses where resources do not meet the VRIO criteria and suggest strategies to improve.
- Recommend at the end to improve the black tea processing in Bhutan to improve its quality and sustainability

Questionnaires to ask farmers.

VALUE

1. What are the primary strengths of your tea production process?
2. How does organic black tea contribute to your profitability compared to non–organic tea?
3. What unique benefits do your organic black teas offer to customers that other producers might not?

RARITY

1. Are there any rare resources like unique soil conditions, specific organic farming techniques, or rare tea plant varieties?
2. How difficult is it for other tea producers to replicate your organic black tea production process?

IMITABILITY

1. What challenges do other producers face when trying to imitate your production methods?
2. What are the costs involved in maintaining the quality and authenticity of your organic black tea?

ORGANIZATION

1. Tell me about the structure of your organization to ensure the efficient production and distribution of Organic black tea?
2. What internal processes or systems do you have in place to support continuous improvement in your organic tea production?
3. How do you manage knowledge and expertise within your team to maintain your competitive advantage in production?

EXTRA QUESTIONS

1. How does the local environment and culture in Trongsa influence your organic black tea production?
2. What kind of support do you receive from government or local organization to improve your tea production?

Appendix C

Record of the Food Production Site Inspection
According to Basic GMP Requirements of Food and Drug Administration, Thailand

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
Section 1: Location, Production Building, Cleaning, and Maintenance				
1.1 The packing building must be distant from sources of contamination, such as waste, hazardous materials, animal barns, dust, smoke, or stagnant water.				
1.2 Around and inside the packing building, there should be no accumulation of unused items or items unrelated to food production.				
1.3 Both the exterior and interior of the packing building should have appropriate drainage pipes or channels with sufficient slope, free from blockages, and designed to prevent stagnant water and dirt, while also ensuring proper drainage.				
1.4 The packing building must be stable, durable, easy to clean, and well–maintained. It should be in clean condition and free from damage.				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
1.4.1 The floor should be made of durable, smooth material, easy to clean, with sufficient slope towards the drainage system, kept clean, and undamaged.				
1.4.2 The walls should be made of durable, smooth material, easy to clean, kept clean, and undamaged.				
1.4.3 The ceiling should be made of durable, smooth material, easy to clean, including any equipment attached to it, ensuring no contamination. It should be kept clean and undamaged.				
1.5 The packing building should be able to prevent animals and insects from entering the production area or encountering food.				
1.6 The packing building should have adequate production space, separate from living areas, and from the production of non–food products as per the Food Act, including dining areas.				
1.7 The packing building should have distinct and separate production areas, laid out according to the production workflow to prevent cross–contamination.				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
1.8 The production building should have a packaging room or measures in place to manage the packaging area to prevent re–contamination after product sterilization **(Major).**				
1.9 The production building should have a ventilation system that controls airflow direction to prevent contamination. There should also be sufficient ventilation to prevent mold growth and facilitate smooth operations.				
1.10 The production building should have adequate lighting.				
Section 1: Total Score =				
Total Score =				
Percentage of Score =				
Section 2: Machinery, Equipment, Production Tools, Cleaning, and Maintenance				
2.1 Equipment, machinery, and production tools that come into contact with food must be designed hygienically, made from suitable materials, easy to clean, and free from corners or seams that are difficult to clean.				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
2.2 Equipment, machinery, and production tools must be installed in appropriate locations, following the production workflow, and should be easy to clean and convenient to operate.				
2.3 The equipment, machinery, and production tools must be suitable for the type of food being produced, the production process, and be available in sufficient quantities.				
2.4 Tables or work surfaces that come into direct contact with food must be designed hygienically, with smooth surfaces made from suitable, non–corrosive materials. They should be easy to clean and elevated at least 60 cm from the floor, or at a level that prevents contamination from the floor during operation.				
2.5 If a piping system is used to transport food, the internal surfaces of the pipes, as well as pumps, connectors, gaskets, and valves that come into contact with food, must be hygienically designed, free from dead spots and corners, easy to clean, and				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
equipped with covers for the ends of pipes that are not in use.				
2.6 Equipment, machinery, and production tools must be regularly cleaned. In the case of equipment used for ready–to–eat food, they must be sterilized before use. Cleaned equipment should be stored properly, in a hygienic manner, and protected from contamination.				
2.7 Equipment, machinery, and production tools must be maintained in good condition, functional, and free from contamination. For equipment with a specified service life, records must be kept, and it should be replaced upon reaching its limit.				
2.8 Measuring and weighing devices must be appropriate, sufficient, accurate, and calibrated at least once a year.				
Section 2: Total Score =				
Total Score =				
Percentage of Score =				
Section 3: Process Control				
3.1 Raw materials, ingredients, and food additives				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
3.1.1 Raw materials, ingredients, and food additives must be selected for quality, safety, and with safety information according to the type of raw material.				
3.1.2 They must be stored on shelves or elevated to prevent contamination, separated and not mixed with hazardous substances or non–food raw materials. If producing allergen–free food, these materials must be stored separately from allergen–containing materials. There must be an efficient system for usage.				
3.1.3 There should be methods to reduce initial contamination from hazards in raw materials or ingredients as needed, such as cleaning, trimming, sorting, blanching, filtering, cooling, or sterilization.				
3.2 Packaging				
3.2.1 Packaging must be selected for quality and safety, appropriate for its intended use, and the condition and integrity of the packaging must be inspected.				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
3.2.2 Packaging should be stored, handled, and used appropriately to prevent contamination, following a first–in, first–out system.				
3.2.3 Packaging should be cleaned or sterilized before use as necessary. Cleaned packaging should be transported in a way that prevents re–contamination. If not used immediately, there must be a system in place to prevent contamination.				
3.3 Mixing				
3.3.1 If food additives are used, they must comply with legal requirements, be measured with appropriate equipment, and be mixed thoroughly. Records must be kept. When using production aids, they must be used according to safety information, and measures must be in place to ensure their safe removal **(Major).**				
3.3.2 Other ingredients must be checked for proper ratios according to the recipe on the label or approved formula, ensuring consistency to maintain quality.				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
3.3.3 Water and ice used as ingredients or in contact with ready–to–eat food must meet the quality standards specified by the Ministry of Public Health. Analytical tests must be conducted at least once a year, and they must be stored in a way that prevents contamination **(Major).**				
3.3.4 During production, mixed ingredients must be stored under conditions that prevent spoilage from microorganisms and cross–contamination, and they must be used efficiently.				
3.4 Control measures must be in place to reduce and eliminate microbiological hazards to a safe level for consumption, with regular inspections and records kept **(Major).**				
3.5 If the production process does not include steps to reduce or eliminate microbiological hazards, such as in the mixing of dry ingredients, oil–based liquids, portioning of dry food, trimming of fresh fruits and vegetables, or packing of fresh food, contamination				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
must be strictly controlled throughout the production process **(Major).**				
3.6 Packaging and sealing				
3.6.1 Packaging and sealing must be done properly, promptly, and at controlled temperatures to prevent the growth of microorganisms. Measures must be taken to prevent re–contamination, and if preservatives are used, they must be applied correctly.				
3.6.2 The integrity of the seals must be inspected.				
3.6.3 Labels must be in good condition and provide sufficient information for consumers to consume the product safely.				
3.7 During the production process, raw materials, ingredients, food additives, and finished products must be moved in ways that prevent cross–contamination **(Major).**				
3.8 Necessary information must be available for traceability, such as the type, production batch, and source of raw materials, ingredients, food additives, packaging, final products, and non–compliant products.				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
3.9 Final products				
3.9.1 Final products must meet quality or standard requirements and undergo analysis at least once a year **(Major).**				
3.9.2 Final products must be stored and transported appropriately for sale, ensuring quality, cleanliness, and preventing cross–contamination from vehicles, workers, and the environment.				
3.10 Records must be kept regarding the type, production quantity, and sales information, including a product recall system.				
3.11 Non–compliant products must be appropriately managed by segregation or destruction.				
3.12 Records and reports must be kept for at least 1 year after the product's labeled shelf life has expired.				
3.13 Internal or external evaluations must be conducted at least once a year by knowledgeable personnel. Any deficiencies found must be corrected.				
Section 3: Total Score =				
Total Score =				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
Percentage of Score =				
Section 4: Sanitation				
4.1 The water used must be clean and suitable for its intended purpose.				
4.2 There should be enough toilets and handwashing stations located near the toilets. They must be hygienic, equipped with liquid soap, hand–drying equipment, or disinfectants, and be separated from the production area or not open directly into it.				
4.3 There should be sufficient and appropriate facilities for changing clothes and storing personal items for workers. These facilities should be conveniently located for use and should not cause contamination.				
4.4 Handwashing stations should be available in the production area in sufficient numbers, functional, appropriately located, and equipped with liquid soap, hand–drying equipment, or disinfectants.				
4.5 Effective measures should be in place to control and eliminate pests and insects. The methods used should not cause contamination.				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
4.6 Waste management must be appropriate and not cause contamination. Waste containers must be suitable, and their placement or the waste collection center should be appropriate. The method and frequency of waste disposal and transportation must not cause contamination.				
4.7 Chemical management measures should be in place, with information on chemicals used. The chemicals must be used safely according to the prescribed method, without contamination. They should be stored separately from the production area, with clear signage. Measures must also be in place to prevent unauthorized persons from using dangerous chemicals without permission.				
4.8 Measures should be in place for managing equipment related to pest and insect control, cleaning, disinfection, and maintenance in a way that does not cause contamination.				
Section 4: Total Score =				
Total Score =				
Percentage of Score =				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
Section 5: Personal Hygiene				
5.1Workers and personnel in the production area				
5.1.1 Workers must not have any diseases or be carriers of diseases. They must not have open wounds, and measures should be in place for workers showing symptoms of illness. **Diseases** -Leprosy -Tuberculosis in a dangerous stage -Drug addiction -Chronic alcoholism -Elephantiasis -Repulsive skin diseases				
5.1.2 Maintain personal hygiene, such as keeping nails short and not wearing nail polish.				
5.1.3 Wash hands thoroughly before starting work and after touching anything that may cause contamination. If gloves are worn, hands must be washed before wearing gloves.				
5.1.4 If gloves are worn when handling food, they must be intact,				

Requirement	Inspection results			Remark
	Good (2 marks)	Adequate (1 marks)	To be improved (0 marks)	
clean, hygienic, and made from materials safe for food contact, without causing contamination.				
5.1.5 Wear a hairnet or hair covering, a clean uniform or apron, and clean shoes while working. Face masks should be worn as necessary.				
5.1.6 Do does not eat or smoke while working, and do not bring personal items, such as jewelry or watches, into the production area. Avoid any behavior that could lead to food contamination.				
5.1.7Workers must undergo appropriate training at each level and have documented proof of their training. They must also strictly follow hygiene warning signs.				
5.2 There must be procedures or practices in place for non–production personnel who need to enter the production area to prevent contamination.				
Section 5: Total Score =				
Total Score =				
Percentage of Score =				

Appendix D

Good Manufacturing Practices (GMP) for Black Tea Production

1. Introduction

This document provides comprehensive guidelines for ensuring consistent quality, safety, and regulatory compliance in the whole production, including packaging and handling of black tea. The implementation of Good Manufacturing Practices (GMP) and Standard Operating Procedures (SOP) is critical to maintaining product quality, ensuring food safety, and meeting industry standards.

This manual is designed for tea manufacturers, producers, and distributors to guide them through the different stages of black tea production mainly focusing on food safety regulations, hygienic practices, and operational efficiency.

2. Overview of GMP in Black Tea Production

Good Manufacturing Practices (GMP) is a set of guidelines and practices to produce safe and high–quality tea. These include maintaining hygiene and equipment standards, proper handling of raw materials, and traceability throughout the production process.

The main areas covered by GMP include:

- **Personnel Hygiene and Training**
- **Facility Design and Maintenance**
- **Raw Material Control**
- **Processing Procedures**
- **Packaging and Labeling**
- **Quality Control and Testing**
- **Documentation and Record–Keeping**

3. Personnel Hygiene and Training

Personnel are the foundation of any production process. Ensuring that employees adhere to hygiene protocols and are well–trained is vital for ensuring that the final tea product is safe for consumption.

3.1 Hygiene Requirements

Personal Protective Equipment (PPE): All workers should wear clean and appropriate PPE (such as gloves, hairnets, aprons, and face masks).

Hand Hygiene: Hand washing facilities should be available at all entrance and regularly maintained. Employees must wash their hands before handling raw materials, tea leaves, or packaging materials.

Illness Reporting: Workers exhibiting symptoms of illness must be prohibited from entering production areas.

3.2 Training

Training Programs: All workers must be trained on GMPs, food safety, and quality control procedures. Employees should be trained on the specific tasks they are responsible for in areas such as proper handling of machinery, tea processing, and quality control.

4. Facility Design

The production facility must be clean, safe, and efficient manufacturing environment. Proper facility maintenance is crucial to prevent contamination and ensure the consistent quality of the tea.

4.1 Facility Layout

The facility should be separated into distinct zones such as raw material reception, processing areas, packaging areas, storage, and waste management. These zones should be labeled and prevent cross–contamination. Adequate ventilation should be provided to maintain air quality and control humidity. Proper lighting for cleanliness and enhances the ability to perform quality control checks.

4.2 Cleaning and Maintenance

The production facility, including floors, machinery, storage, and packaging areas, should be cleaned regularly. A cleaning schedule should be established and followed. Equipment must be inspected regularly for proper functioning. Preventive

maintenance should be performed according to a set schedule to minimize breakdowns and contamination risks.

4.3 Pest Control

A pest control program must be in place to prevent contamination from rodents, insects, and other pests. This includes sealing entry points, using traps or repellents, and regular inspections

5. Raw Material Control

The quality of the raw materials used in black tea production directly impacts the final product. Therefore, proper handling, storage, and documentation of raw materials are essential.

5.1 Sourcing and Inspection of Raw Materials

Only approved suppliers who meet required quality standards should be used for sourcing tea leaves, packaging materials, and other ingredients. All raw materials should be inspected for quality upon arrival. This includes checking contaminants, damage, and expiration dates. A traceability system should be in place to track the origin and movement of raw materials. This ensures that in the event of a quality issue, the affected batch can be traced and managed.

5.2 Storage of Raw Materials

Tea leaves should be stored in a dry, cool place, away from direct sunlight and excessive moisture. The same applies to packaging materials. A proper stock rotation system should be followed (First In, First Out – FIFO) to ensure that older raw materials are used first.

6. Packing Materials

Focusing on packing materials in black tea production lies in the significant role packaging plays in maintaining product integrity and meeting consumer needs. Proper packaging protects tea from contamination, moisture, light, and air, all of which can negatively affect its quality and shelf life. Furthermore, with growing environmental concerns, the use of sustainable, recyclable, or biodegradable packaging materials is increasingly vital to reduce waste and meet regulatory and consumer expectations. By selecting the right packing materials, tea producers can

enhance the product's appeal, reduce environmental footprint, and ensure that the tea reaches consumers in optimal condition, all while adhering to industry best practices for sustainability. Packaging materials play a crucial role in the preservation, protection, and presentation of black tea, ensuring that the product reaches consumers in optimal condition. These materials must fulfill various functions, and to achieve these functions, certain attributes are required. The attributes are, in turn, accomplished through specific methods, which are designed to enhance the effectiveness of the packaging and align with industry standards. This section will explore the functions, attributes, and methods of packaging materials used in black tea production.

Once the tea is processed, it is ready for packaging. The packaging process is critical to maintaining product quality, ensuring the tea is protected from contamination, and complying with regulatory labeling requirements.

6.1 Packaging Materials

Packaging materials, such as bags, boxes, and labels, must be of food–grade quality and sourced from approved suppliers. Packaging materials should be stored in a clean, dry environment to prevent contamination.

6.2 Packaging Process

Packaging machines must be calibrated regularly to ensure accurate weight and sealing. Packages should be sealed securely to maintain freshness. Labels should include necessary product information, such as the batch number, production date, and expiration date.

6.3 Quality Control During Packaging

Each batch of packaged tea should be inspected for consistency in labeling, sealing, and packaging integrity. The packaging process should be documented to maintain traceability of the final product.

7. Processing Procedures

The manufacturing process for black tea involves several stages, including withering, rolling, fermenting, drying, and sorting. Each stage should be carefully controlled to maintain quality and prevent contamination.

7.1 Withering

Process: Fresh tea leaves are spread out in a thin layer to allow them to wilt and reduce moisture content. This helps prepare them for rolling.

Control: Temperature and humidity should be monitored to ensure optimal conditions for withering. The process should be timed to prevent over–drying.

7.2 Rolling

Process: Withered leaves are mechanically or manually rolled to break the cell walls and release juices. This step is essential for the oxidation process.

Control: Rollers should be regularly cleaned to prevent contamination. The pressure and duration of rolling should be standardized to ensure consistent quality.

7.3 Fermentation (Oxidation)

Process: The rolled leaves are allowed to oxidize, which deepens the flavor and color of the tea. This is a critical step in black tea production.

Control: Temperature and humidity must be carefully controlled to achieve the desired level of oxidation. The process should be regularly monitored.

7.4 Drying

Process: After oxidation, the tea leaves are dried to stop the fermentation process. This is typically done using hot air.

Control: The drying temperature should be carefully controlled to avoid over–drying, which can degrade the flavor.

7.5 Sorting and Grading

Process: Once dried, the tea leaves are sorted by size and grade. High–quality leaves are separated from lower–quality leaves.

Control: Sorting equipment should be cleaned regularly to prevent cross–contamination. Grading standards should be consistently applied.

8.Quality Control and Testing

Quality control (QC) is essential to ensure that the final product meets the required standards for safety and quality.

8.1 Testing During Processing

Regular testing of moisture content is crucial to ensure that the tea is not too dry or too moist. Tea samples should be evaluated for flavor, color, and aroma at various stages of production.

8.2 Final Product Testing

Tea should be tested for microbial contamination, including molds, bacteria, and yeast. Testing for pesticide residues, heavy metals, and other chemicals should be conducted regularly. A final inspection should be done to ensure that each package is sealed properly and meets labeling standards.

9. Documentation and Record–Keeping

Proper documentation is crucial for traceability, quality control, and compliance with regulations.

9.1 Record–Keeping Systems

Detailed records should be kept for each batch of tea produced, including information on raw materials, processing steps, and test results. Maintenance, cleaning, and calibration logs for machinery and equipment must be kept up to date.

9.2 Compliance with Regulatory Requirements

Ensure that the production process adheres to local food safety regulations and industry certifications (e.g., HACCP, ISO 22000). Regular internal and external audits should be conducted to assess compliance with GMPs and SOPs.

10.Environmental

Implementing GMP in black tea processing lies in the need to maintain product quality, safety, and sustainability. By adhering to standardized practices, the risk of contamination and deviations from product specifications can be minimized, leading to safer tea production. Furthermore, the application of GMP principles will foster better control over the production environment, increase operational efficiency, and improve consumer confidence in the final product. This will support the long–term sustainability and profitability of black tea production in both local and global markets.

10.1 Introduction

The black tea production is a complex process of multiple stages starting from harvesting till final product to consumers. Safety regulations, Good Manufacturing Practices (GMP) are important to ensure the tea meets quality standards. This document outlines the detail GMP guidelines for black tea processing, focusing on quality control, hygiene, safety, and environmental responsibility. The goal is to enhance productivity, ensure product consistency, and reduce the environmental footprint, contributing to sustainable tea production.

10.2 Environmental Legislation

Environmental legislation plays an important role to make sure that the black tea production process complies with national and international regulations related to environmental protection. Key regulations mainly include waste management, air emissions, water usage, and the use of agrochemicals. Tea processing facilities must follow these laws to reduce pollution, conserve natural resources, and biodiversity. Compliance with environmental regulations helps avoid penalties and supports the tea industry in meeting sustainability standards that are increasingly important to consumers and to maintain reputation.

10.3 Environmental Impact of Process

The black tea processing process can have several impacts on environment, including the water, energy, and raw materials consumption and the waste production. Water usage is important for washing, steaming, and oxidation of black tea leaves. Excessive water consumption and improper disposal of wastewater can lead to water scarcity and pollution. Energy consumption, especially during the drying and withering processes, contributes to greenhouse gas emissions if fossil fuels are used. It is crucial to adopt energy–efficient practices, waste reduction techniques, and eco–friendly pest management methods to minimize the environmental impact of black tea processing as the use of harmful pesticides and fertilizers can lead to soil degradation and water pollution.

10.4 Packaging

Packaging ensures that the quality and safety of black tea considering the consequences on the environment. Sustainable packaging options (like biodegradable, recyclable, or reusable materials) should be prioritized to reduce plastic waste. Design

of a packaging should also prevent contamination, preserve the freshness of tea, and meet regulatory requirements for labeling. Proper packaging ensures that the tea is protected during transportation and storage, reducing product loss and waste. GMP for black tea processing must also include the reducing of excessive packaging and promoting the recycling of materials.

10.5 Miscellaneous

Additionally, GMP should also focus on other factors such as health and safety of worker, quality control, and continuous improvement. Tea processing facilities must provide adequate training for workers to reduce knowledge gap and follow hygiene standards. Regular quality control to ensure that the final product meets the standards and facilities should be open to feedback for continuously reviewing and improving their practices to stay in track with industry best practices, technological advancements, and environmental sustainability goals. Focusing on these elements contribute to the overall success and sustainability of black tea production.

Appendix E

Standard Operating Procedures (SOP) for Black Tea Production

1. Purpose

To outline the standardized process for producing black tea in Bhutan.

To ensure consistent quality and compliance with organic production standards.

To maximize flavor, aroma, and overall quality while maintaining food safety.

2. Scope

It applies to all employees involved in the processing unit.

3. Responsibility

Tea Process Manager: oversees the entire process, ensures adherence to guidelines, and is responsible for monitoring critical control points.

Processing Staff: complete the specific tasks as per instructions and report any deviations.

Quality Control Staff: monitor every step like fermentation and drying processes.

4. Instructions & Frequency

Process	Instruction	Purpose	Frequency	Monitoring	Corrective action
1.Harvesting	Harvest black tea leaves at 9 am sharp.		Daily or as required during harvesti	Ensure leaves are collected without damage.	If leaves are damaged, sort and remove from the batch.

Process	Instruction	Purpose	Frequency	Monitoring	Corrective action
			ng season.		
2.Withering	Wither in a designated room for 5–6 hours.	Reduces moisture content and prepares the leaves for rolling.	Per batch.	Record time and ensure the room is properly ventilated.	If withering is incomplete, extend time in the room.
3.Rolling	Roll the leaves for 2 hours to break down cell walls and release enzymes.		Per batch.	Check the uniformity of the roll.	Adjust rolling time or technique if leaves are not sufficiently rolled.
4.Fermentation (1^{st} stage)	Keep the rolled leaves on a table for fermentation (first stage) for		Per batch.	Observe color changes periodically.	If fermentation is too slow or fast, adjust environmental conditions (temperature/humidity)

Process	Instruction	Purpose	Frequency	Monitoring	Corrective action
	4 hours. Start checking the color after 2 hours.				
5.Roasting (initial)	Roast the leaves at 200 º c for 20 minutes.		Per batch.	Check the color and aroma during roasting.	If leaves are over/under roasted, adjust temperature or roasting time.
6.Cooling	Leave the roasted leaves on a table to cool.		After each roasting.	Ensure that the leaves cool evenly.	Redistribute leaves if uneven cooling occurs.
7.Secondary Roasting	Roast the leaves again at 200 º c for 10 minutes after turning (but without heating for the first 10 minutes).		Per batch.	Ensure that the leaves achieve the desired crispness and flavor profile.	Adjust the roasting time if over/under roasted.

Process	Instruction	Purpose	Frequency	Monitoring	Corrective action
8.Fermentation (2^{nd} stage)	Place the leaves in airtight plastic and apply a heavy object on top to exclude air. Ferment for 2 days.		Per batch.	Check moisture and fermentation status at intervals.	If fermentation is uneven, redistribute the weight or reseal the packaging.
9.Final Drying	Put the leaves in a drying machine at 94 ° C.	To reduce moisture until fully dry.	Per batch.	Measure moisture content during drying.	If leaves are too moist or dry, adjust drying time or temperature.

5. Monitoring

- Fermentation: Monitor time, temperature, and humidity during both fermentation stages.
- Roasting: Keep track of time, temperature, and the color of leaves.
- Moisture Control: Use moisture meters to ensure proper drying.
- Log Keeping: All steps must be logged with start and end times, including corrective actions.

6. Corrective Actions

Under Withering: Extend the withering process or adjust room conditions.

- Uneven Rolling: Modify rolling technique or repeat the process.
- Over/Under Roasting: Adjust the roasting time or temperature.
- Improper Fermentation: Adjust pressure on the leaves or improve the airtight sealing.
- Moisture Imbalance: Modify drying time and temperature to achieve the correct moisture level.

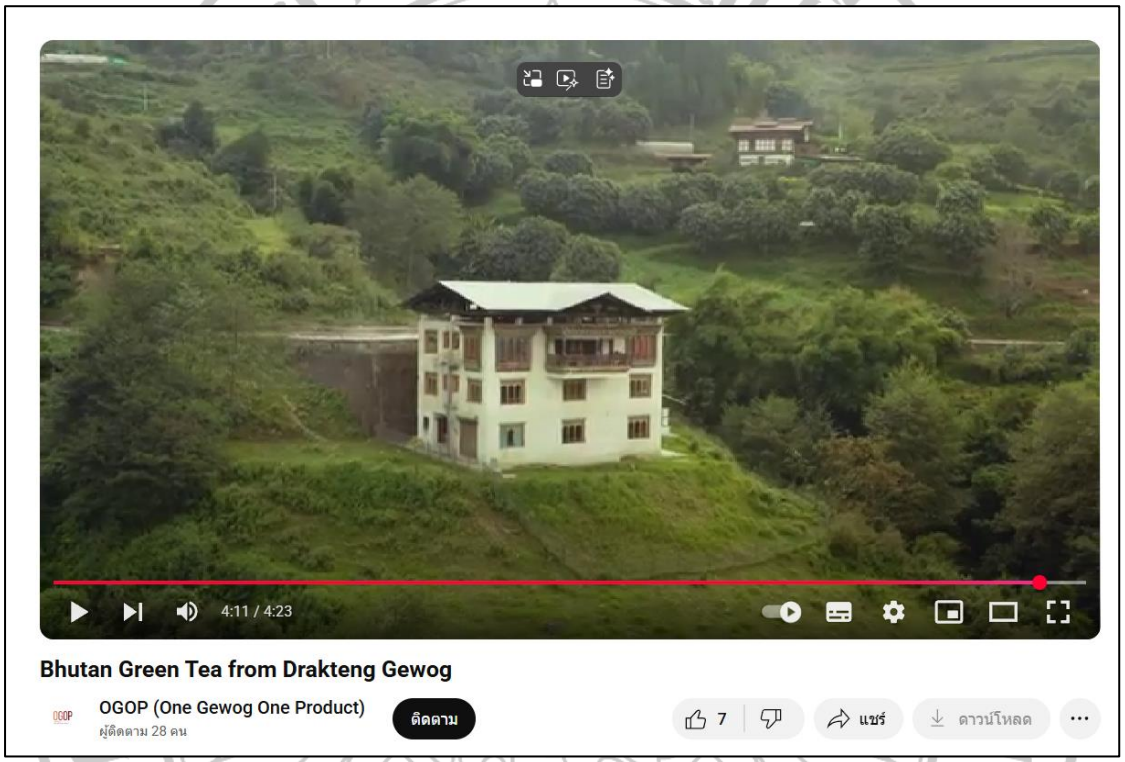
7. Safety Considerations

- Wear protective gear when handling heated tea leaves or operating machinery.
- Ensure proper ventilation in roasting and drying areas.
- Follow fire safety protocols during roasting.

APPENDIX F

YouTube Link

Bhutan Tea from Drakteng Gewog



Source : YouTube https://www.youtube.com/watch?v=zr6ualxnnUI&t=214s

APPENDIX G

Tea Practical in Chiang Mai and Chiang Rai, Thailand

APPENDIX H

Bhutan Tea Products

APPENDIX I

Certificates of International Presentations

ABRS168016

ICSTI-MJU

FACULTY OF SCIENCE, MAEJO UNIVERSITY

CERTIFICATE OF PRESENTATION

the 5th International Conference on Science Technology & Innovation-Maejo University (ICSTI-MJU 2025)

THIS CERTIFICATE PROUDLY PRESENTED TO

Pelden Wangchuk, Supot Boonreang, Watcharapong wattanakul, and Naksit Panyoyai

for the successful presentation of the research work entitled:

"HAZARD ANALYSIS AND CRITICAL CONTROL POINTS (HACCPs) FOR SUSTAINABLE VALUC CHAIN OF BHUTAN ORGANIC BLACK TEA"

in the Oral Presentation under Track Biological Science & Environment

at the 5th International Conference on Science Technology & Innovation-Maejo University (ICSTI-MJU 2025) held on March 28, 2025 at Faculty of Science, Maejo University, Chiang Mai, Thailand

Presented in recognition of the author's valuable contribution to academic and scientific exchange.

T. Cheunbarn

Asst.Prof.Dr.Tapana Cheunbarn
Dean of Faculty of Science, Maejo University

Kampus Merdeka

CERTIFICATE

No. 001/Sert/SK/ICoASTES2024

THIS CERTIFICATE IS PROUDLY PRESENTED TO

MR. PELDEN WANGCHUCK

as Participant

In the First International Conference on Agricultural Science, Technology, Economics and Sustainability (1st ICoASTES)
"Circular Economy For Future and Sustainable Agriculture: Opportunities and Challenges"
held by the Faculty of Agriculture, Universitas Jambi.
Jambi - October 30, 2024

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Assistant Professor Att Atchariyamontree
The Dean of Faculty of Agricultural Technology
Chiang Mai Rajabhat University, Thailand

International Moderator

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