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## Contemporary drying technologies for CTC tea

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### Abstract

Tea is the most widely consumed beverage worldwide and one of the most common and cheapest commodities. The final step in the processing of tea is drying, and uniformity in this step is crucial to maintaining the quality of the tea. This study compares contemporary drying techniques such as a tray, vacuum, solar vacuum, and greenhouse for CTC tea. The results reveal that solar vacuum drying and greenhouse drying are not as fast as a tray and vacuum drying but are economical and eco-friendly. Furthermore, drying takes place at lower temperatures, preserving tea's aroma and other essential constituents. Therefore, it is crucial to look for less expensive and more environmentally beneficial non-conventional sources of tea drying.

**Keywords:** CTC tea, solar vacuum drying, sun drying, tray drying, vacuum drying

### Introduction

Every day, hundreds of millions of people across all continents enjoy the pleasant, popular, economical, safe, and socially-accepted drink known as tea (Khan and Mukhtar, 2007) [4]. Tea has many health benefits, including anti-tumour, anti-carcinogenic, anti-arteriosclerotic, and antioxidant properties (Luczaj and Skrzydlewska, 2005; Adnan *et al.*, 2013) [5, 1]. The tea industry in India occupies an important place and plays a good part in the national economy. India stands 2<sup>nd</sup> place after China in the world in tea production, while it is the fourth largest exporter after China, Kenya and Sri Lanka, respectively. India is the world's largest tea consumer since nearly 50% of the tea made is consumed by Indian citizens (Pazir and Mushtaq, 2021) [3]. Tea contributes significantly to India's foreign exchange earnings as a major export commodity.

The steps often followed in industrial tea production are plucking, withering, rolling or macerating, fermentation, and drying. Drying is the final step in tea manufacture, which refers to removing water from a moist material using heat as the energy input. The drying mechanism is a complex phenomenon involving mass and heat transport from the interior of food materials. It is done to stop the oxidation process, and the leaf colour turns from coppery red to black (Chen and Mujumdar, 2010) [2]. The main drying goal is to achieve a target moisture content of 3 to 5% (wb) with the least energy and quality loss. The drying process must be maintained as short as possible to prevent quality losses. So, drying is a significant challenge to reduce the moisture content to a certain low level while maintaining the quality attributes and simultaneously economizing the energy consumption. Some of these constituents get lost by processing tea at a high temperature, affecting the tea's final quality. These losses can be minimized by heating the leaves at a low temperature. The study compared contemporary drying strategies, *viz.*, tray, vacuum, solar vacuum and greenhouse, for drying CTC tea.

**Greenhouse drying:** The greenhouse drying technology can dry fermented tea leaves. The benefits of using solar energy for drying are 1) energy savings and 2) producing the best possible finished product. It dries the tea leaves at a low temperature, so the final product's quality is maintained, producing a higher yield. The greenhouse drying technology also removes humidity from the incoming air because it is heated before it enters the drying chamber, which means the air has been preconditioned to absorb moisture.

**Vacuum drying:** In vacuum drying, moisture removal occurs at low pressure. The low pressure reduces drying temperature, which improves tea leaves' colour and aroma. So, the study of drying tea leaves in a vacuum dryer is a novel method of drying that saves energy and improves the quality of tea.

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**Tray drying:** In the tray dryer, fermented leaves are spread on the trays and dried by hot air and conduction from heated trays.

### Materials and Methods

**Plucking of Tea:** The young leaves and terminal buds of the tea plant were plucked from the tea garden of the Agricultural and Food Engineering Department, IIT Kharagpur, located near Gopali village. Green leaf was processed to have fermented tea for the final drying experiment. Tray, vacuum, solar, and greenhouse drying processes were considered for drying purposes.

**Withering:** The leaves were spread on a trough after plucking and weighing. Withering primarily aimed to reduce the moisture content to 65-70%. It took around 20 hours.

**Maceration:** A vertical maceration device was used to macerate withered tea leaves. The machine has three vertical blades around the vertical shaft. This shaft rotates about a vertical axis by the electrically driven motor. Leaves are fed from the top, and the macerated product comes out at the bottom.

**Fermentation:** After maceration, leaves were spread over a tray, maintaining 1" thickness and humidity greater than 90%. The oxidation time for CTC was around 45-50 minutes. Fermentation time for orthodox is approximately 1 hour 30 minutes.

**Drying:** Drying is a significant step in tea manufacture which refers to a process in which water is removed from the fermented leaf by using heat as energy input. The objective of drying is primarily to achieve a target moisture content of upto 3-4% with minimal use of energy and minimal loss in quality. Tray, vacuum, solar vacuum, and greenhouse dryers

were used for drying. Loss of moisture content was recorded at 10 min intervals till moisture content reached 3-5%. Moreover, in a tray and vacuum dryer temperature was fixed at 77 °C.



Fig 1: Solar vacuum dryer



Fig 2: Greenhouse dryer used for drying CTC tea

### Result and Summary

Tea was produced in four stages: withering, maceration, fermentation and drying. It takes between 14 and 18 hours to wither. The orthodox and CTC teas are determined via rolling and maceration, respectively. The CTC tea takes 60 to 90 minutes to ferment.

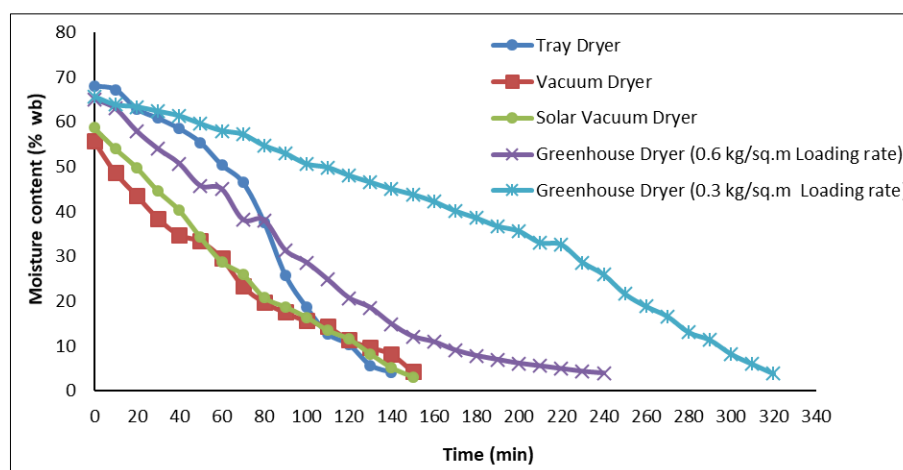


Fig 3: Drying curve of different contemporary drying techniques used for CTC tea

A commercial hot air dryer, i.e. endless chain pressure dryer, is used in the tea industry to dry products by passing hot air over them at 120 °C. Tea is evaluated based on its colour and aroma. The colour and aroma of tea come from different constituents, like polyphenols. At high temperatures, some of these constituents get lost, affecting the final quality of the made tea. Low temperatures can minimize these losses (Shinde *et al.*, 2013) [6]. As we can see from the graph, solar

vacuum drying and greenhouse drying are not as fast as a tray and vacuum drying methods, but they are far more economical.

Moreover, when drying occurs at lower temperatures, preserving the aroma and other essential constituents of tea. When leaves are dried at low temperatures, there is less chance that they may burn. From figure 3, we can observe that although the drying rate in greenhouse drying decreases

as the loading rate increases as expected, it then starts to follow a more constant rate of drying, which is desirable. Tray drying and greenhouse drying are slower than vacuum drying. For tray drying, the drying rate initially follows a constant rate, then drops steeply and again follows a constant rate. In a vacuum dryer, the drying rate is faster as the outside chamber pressure is less than the inside pressure of the tea leaves, thus forcing the water inside the leaves to come out quickly and resulting in a faster drying rate.

### Conclusions

In the tea drying industry, conventional techniques of tea drying are prevalent and costly. This raises the price of tea in the finished product, making it more expensive. It is necessary to explore contemporary drying techniques for tea drying which are economical and more eco-friendly. These techniques not only lower the price of tea but also maintain the aroma and other constituents. Small-scale industries do not have the capital to employ endless chain pressure and fluidized bed dryers for drying purposes. These greenhouse drying methods are less expensive and more beneficial for these cottage industries that produce 100kgs of tea per day. This concept of tea drying, when employed in the tea industry, will result in better quality tea at a lower cost.

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