Ambient humidification of CTC and CFM room: its effect on quality of tea

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Abstract

During black tea processing, visible changes take place in the oxidation stage. Regulated and controlled environment is crucial to optimize the process. The control parameters for oxidation process are, availability of oxygen, temperature, humidity and time. Humidified air is supplied into the fermenting systems – Floor, Gumla or CFM – to ensure an oxygen rich humid environment. Elevated humidity restricts depletion of moisture from the CTC processed leaf. A hygrometric difference of around 1-2 ^{0}C is recommended for the above. This in turn also helps in reducing the room temperature closer to the recommended level of 27-30 ^{0}C. In most commercial tea factories, spot humidifiers and overhead duct humidification system are used. But they are being rapidly replaced by more efficient misting or fogging systems which enable ambient humidification with micro fine droplets.

This paper presents the results of the trials conducted with a High Pressure Fogging System which was installed at the Model Tea Factory, TTRI, Jorhat. The effect of this technology was extensively assessed/reviewed in fermented *dhool,* as well as on made tea over a period of two years. Results show that it was possible to achieve a humidity of 91.8% to 95.9% inside the fermenting room while the prevailing ambient humidity levels recorded varied from 71.9% to 74.40%. The appearance of the treated samples on fermentation bed was very bright and the made teas were preferred by the tasters. However, the above observations were more pronounced on days of low ambient humidity, in which case the tasters' scores on made tea were significantly higher with respect to brightness, briskness, strength and quality, compared to the control samples.

Key words: Misting system, Fogging system, Cooling systems, Humidifiers, Polyphenols, Theaflavins, Thearubigins.

Introduction

Tea, one of the most popular drinks in the world, is processed essentially from tender shoots, comprising of two or three leaves and the terminal apical buds of the tropical shrub *Camellia sinensis var. Sinensis* or *Camellia sinensis var. Assamica* or other Southern varieties [1]. All types of tea e.g., black, green, oolong, yellow, white, matcha, instant etc. are produced from the same plant. To produce black tea, the plucked green leaves are withered, macerated, oxidized and dried [2,3]. Among all these steps, oxidation, popularly termed as fermentation in tea parlance, plays a pivotal role in determining black tea quality [4,5,6,7]. In this process, the

processed leaf or *dhool* changes colour from green to brown and finally to bright coppery brown [9]. Thus, optimally fermented tea depicts uniform colouration of all particles and has a fruity smell. Under-fermented tea is inhomogeneous in colour with greenish tint on a few particles and has a grassy smell, while, over-fermented tea is dark red and is characterized by a bitter taste [10,11].

During fermentation, polyphenols, more precisely the catechins, undergo enzyme-catalyzed oxidative reactions to form theaflavins (TFs), thearubigins (TRs) and other polymerization products [12]. TFs, TRs and unoxidized polyphenols contribute to the distinctive sensory properties like mouth feel and astringency, brightness and colour of a tea brew [13,14,15]. The ratio of TF and TR changes with various fermentation times [16]; and the best TF:TR ratio is considered to be 1:10 [17].

Some of the factors that influence fermentation are intrinsic to the material in use and others arise out of the processing conditions. The major intrinsic property is genetic in nature and is often referred as fermenting potential or *fermentability* of the cultivar; whereas the processing conditions are extent of withering, rolling, oxygen availability, fermentation time, relative humidity and temperature. It is crucial that optimum conditions are maintained to achieve the desired level of oxidation [18]. Among the aforesaid processing conditions, relative humidity and temperature are environmental factors. These two parameters are independent of the effect brought about by the other processing conditions on the material under process, that is, the *dhool*. In other words, humidity and temperature of the fermenting area are parameters which need to be maintained within the desired level, irrespective of the condition of the *dhool*, during the process of fermentation [19,20]. These two parameters play a pivotal role in the development of key quality factors. A hygrometric difference of around 1-2 ^{0}C is recommended in the fermenting area to restrict depletion of moisture from the CTC processed leaf and maintain the humidity of the room at an elevated level. This improves the fermentation process, resulting in a blacker tea with improved liquor characteristics and a higher market value. On the other hand, room temperature closer to 27-30 ^{0}C is recommended under Assam conditions for development of optimum quality during fermentation.

To maintain the above conditions, all tea factories use artificial form of humidification. Traditionally, the most common humidification system used in CTC factories are spot humidifiers. The continuous fermenting machine (CFM) however supplied with central humidification chambers to supply humidified air through the tea bed. But both the systems are often found to be inadequate in preventing moisture loss, particularly from the layer on the top of the fermenting bed. Loss of up to 10 percent moisture between inlets in Rotorvane and drier are not uncommon.

This paper highlights the results of trials with a new fogging system from F. Harley & Company Pvt. Ltd., Kolkata, which was installed in the CTC and CFM room of Model Tea Factory, Tocklai. The system could achieve a humidity of 95.9% & 91.8% inside the room while the

ambient humidity levels recorded varied from 74.40% to 71.9%, respectively. The appearance of the treated samples on CFM bed was very bright, compared to the untreated samples.

Materials and Method

Under a pilot project between Tocklai Tea Research Institute, Jorhat and F. Harley & Company Pvt. Ltd., Kolkata a study was undertaken to document the effect of high efficiency humidification system during fermentation of CTC. A room humidification system was installed in the CTC and CFM areas in Model Tea Factory at Tocklai (figure 1). The humidification system primarily comprised of a high-pressure pump (1000 PSI) with wall mounted misting fans which generates and spreads micro fine mist, enabling humidification across a wide application area. This installation was completed in July 2019 and was in regular use to effectively humidify the ambient of CTC and fermentation process.

The working principle of the F. Harley's Humidikool humidification system is based on 'Flash Evaporation' technique [21]. Micro droplets of water absorb the latent heat from the ambient and evaporate instantly which results into a temperature drop closer to Wet Bulb temperature, at the same time maintaining a uniform humidity level. Total 35 nozzles were fitted to deliver miniscule water droplets of 1 – 10 microns into the CTC & CFM room. The nozzles were connected through a high-pressure pump. For effective and fast humidification, seven fans were fitted at a height of 15 feet (approximately) in the room having an area of 3660 sq.ft. The nozzles were mounted on the casing of the fans such that the mist and air is delivered co-axially (figures 2 a. and 2.b).

Figure 1: Room humidification system at MTF, Tocklai.

Figure 2a: Co-axial delivery of mist and air from room humidification system at MTF, Tocklai.

Figure 2b: Close-up view of humidification at MTF, Tocklai.

To evaluate the efficiency of the F. Harley's Humidikool humidification systems, 70 sets of trials were taken during tea processing, both with and without the system in operation. The average readings of the quality parameters, both chemical and organoleptic, were compared to see the major variations in the quality of tea.

Results and Discussion

Manufacturing trials were carried out with the Humidikool humidification systems during the period from April to November to measure its efficacy. Relative humidity (RH) data showed that it was possible to achieve of 95.9% to 91.8% inside the fermenting room, while the ambient RH varied from 74.40% to 71.9%.

Made tea samples were taken from each trial with and without the humidification and compared. Results of chemical analyses and organoleptic assessments of the samples are presented in Figures 3 & 4 below:

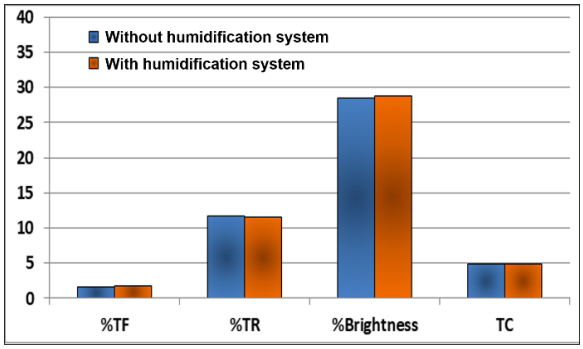

Fig.3: Variation in biochemical quality parameters of made tea with and without humidification

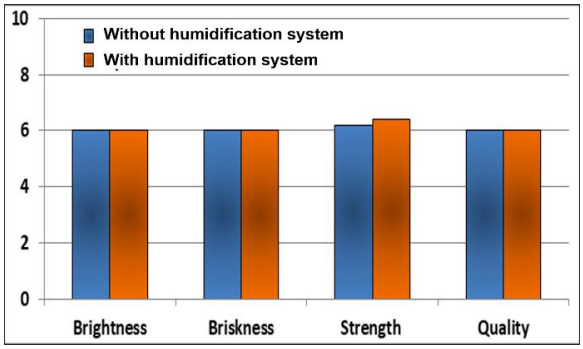

Fig. 4: Variation in organoleptic parameters of made tea with and without humidification

From the comparative bar graphs, it can be observed that overall average readings of the quality parameters, both chemical and organoleptic, did not show major difference in the quality of tea. However, on days of low ambient humidity the taster preferred the samples manufactured with humidification. This is obvious from the graph on organoleptic evaluation of the samples which shows a significant improvement in all parameters (Figure 6). The above however could not be observed in the trend shown by the biochemical parameters (Figure 5).

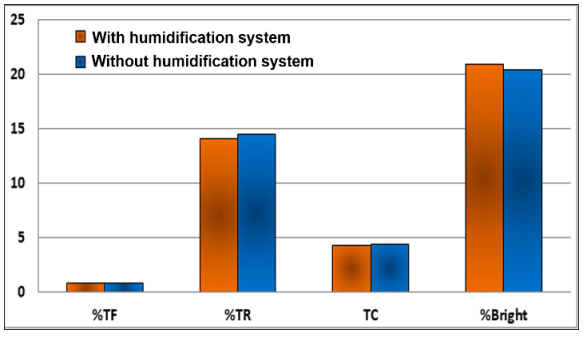

Fig.5: Variation in biochemical quality parameters of made tea with and without humidification on days with low ambient humidity only.

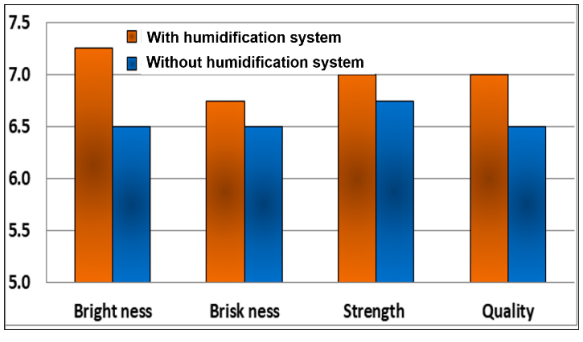

Fig. 6: Variation in organoleptic parameters of made tea with and without humidification on days with low ambient humidity only.

These observations indicated enhancement in quality of made tea on days with low ambient humidity. Further, appearance of the treated samples on CFM bed was very bright, compared to the untreated samples.

Conclusion

Pilot scale manufacturing experiments have established earlier that humidified ambient conditions with low temperature is ideal for fermentation of CTC. The results from this experiment could establish that a larger space, as in CTC and CFM room in a commercial factory, might also be effectively humidified upto 92 to 96% RH and temperature maintained to 27 to 30 ^{0}C with the help of F. Harley's high efficiency Humidikool humidification system.

Further study needs to be conducted on the possibility of embedding the humidification system within the CFM duct and its effect on quality. Such a system might also help to eliminate the use of central humidification chamber and simplify the ducts attached to a CFM.

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