Pre-drying of fermented black tea leaves using far-infrared

H.M.N.P. Kumara[1], G. Abhiram[1, 2*], K. Raveendran[3], K.G. Prematilake[1]

[1] Department of Export Agriculture, Faculty of Animal Science and Export Agriculture Uva Wellassa University, Badulla, Sri Lanka.
[2] School of Agriculture & Environment, Massey University Private Bag 11 222, Palmerston North 4442, New Zealand.
[3] Process Technology Division, Tea Research Institute, Thalawakelle, Sri Lanka.
** gabhiram004@gmail.com*

1. Introduction

Orthodox broken types of tea are produced in about 130 tea factories in Sri Lanka. Fluid bed tea driers (FBD) are the preferred option to dry the types of tea. The FBDs are available in different sizes and their output varies between 220 and 360 kg dried-tea hr^{-1}. During tea drying, chemical reactions are arrested and its moisture content is reduced to 3%. The main drawback of the FBD method is using firewood as the main source for producing hot air for drying tea. This releases harmful gases (carbon mono and dioxides) and it is difficult to find dried firewood during the wet season. To overcome these limitations, far-infrared (FIR) could be used as an alternative source of tea drying.

Far-infrared (FIR) has been used to dry many food commodities (Abhiram & Amaratunga, 2014). It does not release harmful toxic substances. This drying method increases energy efficiency, decreases the processing time, provides uniform heating and has a high heat transfer coefficient (Sakare et al., 2020). Only limited knowledge is available for the application of FIR for tea drying. For example, Subankan et al. (2016) developed a batch-type FIR tea dryer and found that the optimum drying conditions were 185 °C and 2.5 minutes of exposure time. In this study, FIR was used for pre-drying of tea leaves since pre-drying could decrease the firewood consumption for FBD drying and arrested the fermentation quickly. The pre-dried tea samples were analysed for (theaflavin (TF): thearubigin (TR) ratio and organoleptic properties, and compared with the factory-made tea samples.

2. Materials and Methods

A prototype tea dryer was developed with four FIR emitters and a thin layer of fermented tea was pre-dried by changing the combinations of temperatures (350, 300, 250, 200 and 150 °C) and exposure times (2.2 and 3.2 mins) (Table 1). The pre-dried tea was dried using a laboratory-scale fluid bed drier. Sensory evaluation was conducted on dried tea by three professional tea tasters and chemical analysis (theaflavin (TF) and thearubigin (TR)) was conducted for quality parameters. Samples of tea dried using conventional fluid bed drier, collected from a typical tea factory (factory samples), were included along with the test teas for the analysis.

Table 01. The sample numbers of the tea dried under different combinations of temperature and exposure time

Time	Temperature				
	350 °C	*300 °C*	*250 °C*	*200 °C*	*150 °C*
2.2 minutes	S1	S3	S5	S7	S9
3.2 minutes	S2	S4	S6	S8	S10

3. Results and Discussion

Results of the 5-point hedonic scale sensory evaluation on dried tea with the estimated median value for liquor characteristics (liquor colour, flavour and aroma), dried tea leave characteristics (appearance and colour) and overall acceptability is presented in a radar graph (Figure 1). The overall acceptability of dried tea samples with exposed temperature of 250 °C & exposed time of 2.2 minutes (S5) and exposed temperature of 250 °C & exposed time of 3.2 minutes (S6) in the FIR pre-drier were superior to most of the other dried tea as well as to factory dried tea sample (Figure 1). Dry leaf colour and appearance are mainly attributed to the results.

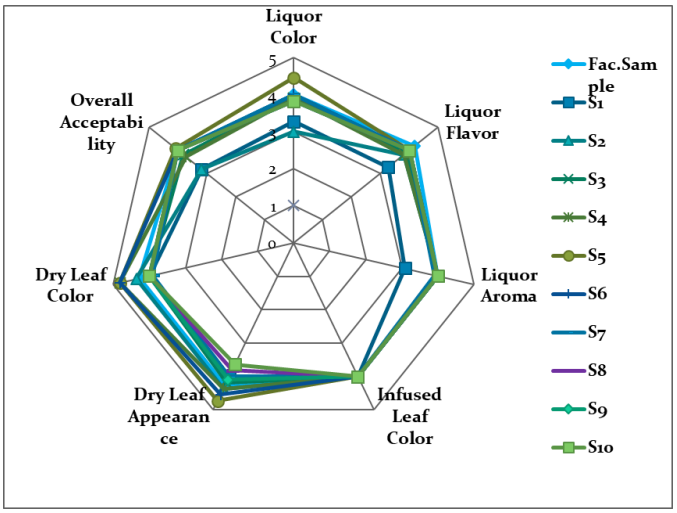

Figure 1. Radar graph for 5-point hedonic scale sensory evaluation of dried tea leaves and tea liquor

The results of the chemical analysis showed a high percentage of theaflavin (TF) and a moderate percentage of thearubigin (TR) in the dried tea samples, S5 & S6. Lowest TR: TF ratio, further attributed to the overall acceptability. Higher percentages of TR in dried teas exposed to 2.2 minutes compared to that with 3.2 minutes at exposure temperatures of 350, 300 & 250 °C indicate post-fermentation reaction. Longer exposure time under the FIR emitter led to arresting of fermentation reactions. Longer exposure time at exposure temperature of 200 & 150 °C facilitated post-fermentation during pre-drying with elevated temperature.

Table 02. The theaflavin (TF), thearubigin (TR) and TF:TR ratio of the samples dried under FIR

Sample	TF%	TR%	TR: TF ratio
S1	0.557	8.838	15.858
S2	0.476	7.519	15.810
S3	0.507	9.124	18.012
S4	0.456	8.456	18.534
S5	0.553	8.724	15.780
S6	0.564	7.750	13.736
S7	0.410	8.838	21.582
S8	0.422	9.057	21.458
S9	0.404	8.541	21.147
S10	0.424	9.236	21.800

4. Conclusions

Fermented tea types were pre-dried under FIR emitter at different exposure time and temperature and finally dried using a laboratory-scale fluid bed drier. Sensory evaluation and chemical analysis were conducted for dried tea samples and factory tea sample. When the exposure time increased from 2.2 to 3.2 minutes, enzymatic reactions appears to be arrested at high temperatures in the range of 250 to 350 °C. The sample dried under 250°C temperature and 2.2 minutes exposure time showed overall better characteristics. These results showed the potential use of FIR emitter for pre-drying of tea before fluidized bed drying.

5. References

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