Effect of Process Parameters on the Quality of Instant Tea

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Introduction

Tea is the main agricultural export of Sri Lanka contributing around 15% to the total exports of the country. Sri Lankan tea is renowned as one of the best blends of tea available in the global market. The number of direct and indirect beneficiaries from the tea industry is considerable.

At present, Sri Lanka exports several varieties of tea including bulk tea, tea packets, tea bags, green tea, and instant tea. Among these, the demand for instant tea is continuously increasing. There are two main types of instant tea: hot water soluble instant tea and cold water soluble instant tea. (Abeysekera, 2005).

The principal operations carried out in manufacturing hot water soluble instant tea are extraction, filtration, evaporation, aroma stripping and aromatization, spray drying and packing. The main indicators of the quality of instant tea include particle size distribution, the total polyphenol content, the thearubigins to theaflavin ratio, and the brightness of the tea (Roberts and Smith, 2001).

In this work, the effect of the important process parameters such as extraction time, extraction temperature and evaporator temperature, on the quality of instant tea was examined.

Materials and methods

Experiment planning

As there were several variables under study and since the production of instant tea and analysis of the quality were expensive and time consuming, a two level factorial experiment design approach was employed to screen out the influential process parameters. The selected process parameters and the relevant levels are shown in Table 1. The upper and lower levels of each parameter were decided based on the range of process parameters used in the industry.

Table 1. Selected process parameters and levels

Parameter	Level	
	Lower (-1)	Upper (+1)
Extraction time /(min)	10	20
Extraction temperature /(°C)	75	85
Evaporator temperature /(°C)	85	95

Production of instant tea

Five liters of distilled water was pre-heated to the required temperature of the extractor as given in Table 1. Then 500 g of tea (tea grade of Broken Orange Pekoe Fannings) was added to pre-heated water, and the temperature was kept constant at the required extractor temperature for the required period of time while stirring. Then the tea brew was strained, and was evaporated in the climbing film evaporator at the Department of Chemical and Process Engineering, University of Peradeniya. The first 100 ml of vapour leaving the evaporator was condensed, collected and added back to the concentrated brew to simulate the aroma stripping operation. The evaporation was then carried out for 90 minutes. The concentrated tea brew was then spray dried at a constant temperature of 95 °C in the spray dryer at the Food research institute, Gannoruwa. The resulting tea powder was then aseptically packed and sealed in triple layered aluminium foil bags to prevent possible moisture absorption.

Quality measurements

The standard procedure for determining total Polyphenol level in instant tea was performed using a Folin-Ciocalteu Colorimetric reagent, with optical density measurements at 765 nm. (ISO working draft, 2005). The standard procedure for determining thearubigin and theaflavin in instant tea was implemented using isobutyl-methyl-ketone (IBMK) and sodium hydrogen carbonate by measuring optical density at 380 nm and 460 nm. (Roberts and Smith, 2001).

Calculation of quality measurement

Theaflavin and Thearubigin content were calculated from the optical density measurements at 380 nm while the brightness was calculated from the optical density measurements at 460 nm (Roberts and Smith, 2001). The total Polyphenol content was calculated from the optical density measurements at 765 nm. (ISO working draft, 2005).

Data analysis

The calculated values for thearubigin content, theaflavin content, total polyphenol content and the brightness values were analysed using the factorial experimental method.

Results and discussion

According to the factorial method, the most influential parameters stay as outliers of the best-fit line in the plot of the normal probability against factor effect. (Montgomery, 1976)

By analyzing the four normal probability plots related to total polyphenol, theaflaving, thearubigin and brightness, the only outlier which deviates from the best-fit line is found in the plot related to total polyphenol, and it corresponds to the interaction of evaporator temperature. (Figure 1).

Interaction plots were drawn to identify significant interactions (Montgomery, 1976). The only significant interaction found was between extractor time and evaporator time. This is indicated in Figure 2. This interaction indicates that the Evaporator temperature has little effect at low Extractor temperature, but a large negative effect at high level of Extractor temperature. This may be due to the sensitivity of Thearubigin to high temperature. When both extractor and evaporator temperatures are high the exposure time of tea for high temperate increase, which leads to the destruction of Thearubigin.

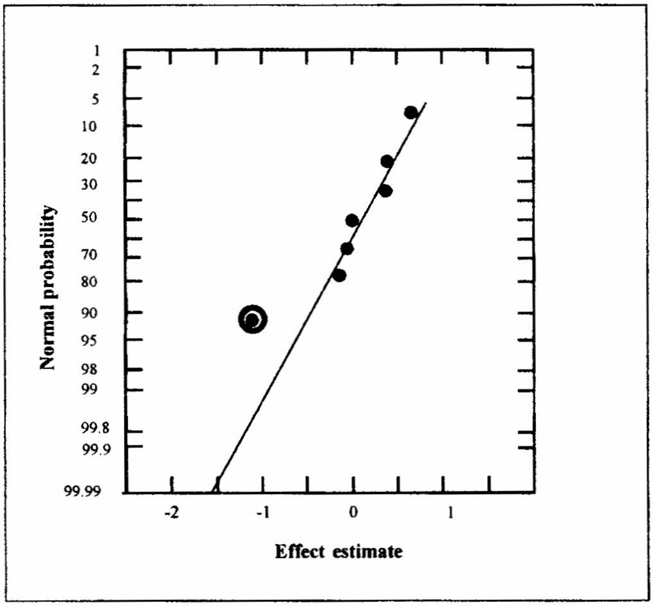

Figure 1. Normal probability vs effect estimate plot for Total Polyphenol

Conclusions

Among the three process parameters, extractor time, extractor temperature and evaporator temperature, analysed in this research, evaporator temperature was identified as the parameter which has the highest influence on the quality of instant tea.

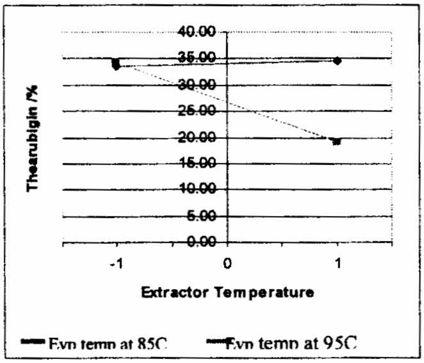

Figure 2. Interaction plot for Thearubigin at extraction time 20 min

References

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