S.L.J. Tea Sci. 68(2), 27-33, 2003, Printed in Sri Lanka

Two-Stage Drying of Black Tea Using Microwave Energy

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Trials on two-stage drying of black tea, a combination of conventional drying followed by microwave drying, have been attempted to determine if two-stage drying would produce a good quality tea with enhanced keeping qualities. Previous studies have shown that microwave energy inhibits polyphenol oxidase (PPO) activity in tea and thereby improves its keeping qualities (Liyanage *et al.*, unpublished data; Liyanage *et al.*,1997).

Trials on miniature scale, as well as on industrial scale, two-stage drying have been carried out. The miniature-scale samples were analysed for theaflavins (TF), thearubigins (TR) and moisture content, and were evaluated for taste. The industrial-scale samples were analysed for TF, TR, moisture content, flavour compounds, PPO activity and microbial count, and were evaluated for taste. The results indicate that the quality of conventionally dried teas are better than that of two-stage-dried teas, both in terms of quality and flavour, while the microbial counts in microwave-dried teas were much less than that in conventionally dried teas.

Key Words: Tea, microwave drying, conventional drying, two-stage drying, polyphenol oxidase.

INTRODUCTION

Preliminary investigations have shown that when fermented dhool is exposed to microwave energy, polyphenol oxidase (PPO) gets inactivated, which would result in enhanced keeping qualities of tea (Liyanage *et al.*, unpublished data; Liyanage *et al.*,1997). Trials on microwave drying, conducted in the factory for both broken-grade and leafy-grade type manufacture, have shown that microwave-dried teas are inferior to conventionally dried teas in terms of liquor characteristics and flavour profile. However, the appearance or the blackness of made tea was better in the microwave-dried teas for broken grades.

Trials on two-stage drying, involving an initial convective drying followed by a microwave finish drying, was investigated in the present study, in order to determine the possibility of producing a good quality tea with enhanced keeping qualities.

MATERIALS AND METHODS

Miniature scale two-stage drying

In a preliminary trial for two-stage drying, the miniature endless chain pressure (ECP) drier at St Coombs Estate was used, in combination with a domestic microwave oven (model: Gold Star MA 1066 ME, Korea).

The following treatments were given to two dhool samples.

50 g dhool 19.2 % moisture	7 min. ECP	Microwave 680 W 3 min. 10 sec.
50 g dhool 15.8 % moisture	9 min. ECP	Microwave 680 W 3 min. 20 sec.

For comparison, the following treatment was given to a dhool sample from the 2nd section of the FBD.

50 g dhool (2nd section FBD) 19.35 % moisture	9 min. ECP	Microwave 680 W 3 min. 20 sec.

A sample dried in the FBD, having a moisture content of 4.2 %, was used as a control.

Each trial was repeated three times, and the mean values of the parameters were recorded for comparison.

Industrial scale two-stage drying

Experiments were carried out at Great Western Estate, Talawakelle. Partially dried samples, 50 g each, from 1st, 2nd and 3rd sections of the FBD drier were taken out, and subjected to microwaves at 680 W for 3, 5 and 1.5 min.

For comparison, a 50 g dhool sample exposed to microwaves for 3 min. at 340 W, followed by 6 min. at 680 W, was used.

A conventionally dried sample was taken from the 4th section of the FBD to be used as a control.

Each trial was repeated three times, and the mean values of the parameters were recorded for comparison.

Microbial analysis

Fifty millilitres of sterilized distilled water were placed in a sterile conical flask containing 2 g of made tea, with 0.05 ml of Tween 80. The mixture was shaken for 20 min. in a shaker. A series of dilutions from this mixture was prepared using sterilized distilled water. Moulds and aerobic plate counts were taken for each dilution, using potato dextrose agar and nutrient agar, respectively. Counts were made after an incubation period of 48 hr at 25 °C.

The experiment was repeated three times.

Determination of TF, TR and total colour

The method used for the determination of TF, TR and total colour (TC) was that of Roberts and Smith (1961).

Determination of flavour compounds

The method used to determine flavour compounds was that of Yamanishi *et al.*, (1989).

Determination of moisture content

The moisture content was determined by the standard AOAC gravimetric method (1999).

Tasters' evaluation

A panel of three tasters were used, and their average ratings were recorded for individual parameters, namely infused leaf, colour, strength, quality and flavour.

RESULTS AND DISCUSSION

Miniature scale two-stage drying

The fired teas from the miniature scale two-stage drying were compared for TF, TR, moisture content and taste. The results are given in Table 1.

Table 1. Comparison of TF, TR and moisture content of two-stage-dried teas with that of conventionally dried teas

Treatment	%TF	%TR	TR/TF	%moisture
ECP 7min+680W/3min10secs	0.77	14.04	18.46	5.4
ECP 9min+680W/3min20secs	0.87	13.99	16.09	5.0
FBD2ndsect^{n}+680W/3min20secs.	0.96	13.95	14.47	5.8
FBD (control)	1.10	13.30	12.72	4.2

On tasting the liquors, it was evident that the teas dried using two-stage drying were thinner, and the infusions duller, than with the conventionally dried teas. The appearance with reference to blackness of tea, for the first three samples, was better than for the FBD-dried samples. The moisture content of the two-stage dried teas was higher than that of the FBD-dried samples.

Industrial scale two-stage drying

The two-stage-dried teas were analysed and compared for TF, TR, moisture content and PPO activity. The results are shown in Table 2.

Table 2. Comparison of TF, TR, moisture content and polyphenol oxidase activity in two-stage-dried teas with that in microwave-dried teas and conventionally dried teas

Treatment	%TF	%TR	TC	%B	TR/TF	%MC	%PPO
340W/3min + 680W/6min	0.699	14.288	0.626	19.726	20.452	3.1	27.16
FBD 1st sect^{n}+680W/5min	0.638	13.871	0.610	19.565	21.745	3.7	41.98
FBD 2nd sect^{n} +680W/3min	0.942	14.503	0.863	19.832	15.402	3.1	80.25
FBD 3rdsect^{n}+680W/1.5min	0.999	15.408	0.913	25.260	15.420	3.4	81.48
FBD 4th sect^{n}	1.018	14.216	0.900	27.950	13.971	4.6	93.83

On comparing the results, it was evident that the TF content of microwave-dried teas, and two-stage-dried teas, is lower than that of conventionally dried teas (Table 2).

The highest PPO activity was observed in the sample that was dried in the FBD (93.8 %), and the lowest in the microwave-dried sample (27.16 %). In the two-stage-dried teas, the PPO activity increased with reduction in time of exposure to microwave energy (Table 2).

Table 3. Comparison of flavour compounds in two-stage-dried teas with that in microwave-dried teas and conventionally dried teas

Treatment	Trans-2 Hexanal ppm	Linalool oxid e-1 ppm	Linalool oxide-2 ppm	Linalool ppm	Methyl ppm	Geraniol salicylate ppm	QI
340W/3min + 680W/6min	3.018	0.119	0.631	0.902	0.019	1.361	0.299
FBD 1st sectn + 680W/5min	7.331	0.326	1.673	2.652	0.048	2.626	0.362
FBD 2nd sectn + 680W/3min	8.028	0.401	1.831	3.560	0.063	3.432	0.444
FBD 3rd sectn +680W/1.5 min	25.115	0.768	3.175	6.804	0.096	3.821	0.271
FBD 4th sectn	33.772	0.793	3.076	6.739	0.170	3.460	0.200

The flavour profile of the teas indicate that the levels of flavour compounds are lower in microwave-dried teas than in conventionally dried teas (Table 3).

On tasting the samples, it was observed that the best liquor was produced by conventionally dried teas, and the next best was the sample from the 3rd section of the FBD which was exposed to microwave energy at 680 W for 1.5 min. The sample dried using microwaves alone had very light and undesirable liquor. The flavour was also more pronounced in the conventionally dried teas than in the microwave-dried teas. The sample that was exposed to microwave energy alone had the best appearance in terms of blackness.

When microwaves are used to dry both broken and leafy-type grades, the quality of the liquor was found to be inferior to that of conventionally dried teas. However, the appearance in relation to blackness was better in microwave-dried teas (Liyanage *et al.*, unpublished data).

Teas that have not been fired properly, and that have a high moisture content, do not give rise to a well-rounded product. When microwaves alone were used to dry broken grades, it was difficult to achieve a moisture content of 3-4 %. However, with leafy grades, this range was achieved, although the quality of both types of liquors

were inferior to that of conventionally manufactured teas (Liyanage *et al.*, unpublished data).

Microbial analysis of made tea samples

All samples were subjected to microbial analysis to check the effect of microwaves on the microbial count. The total number of microbes for each sample is given in Fig. 1.

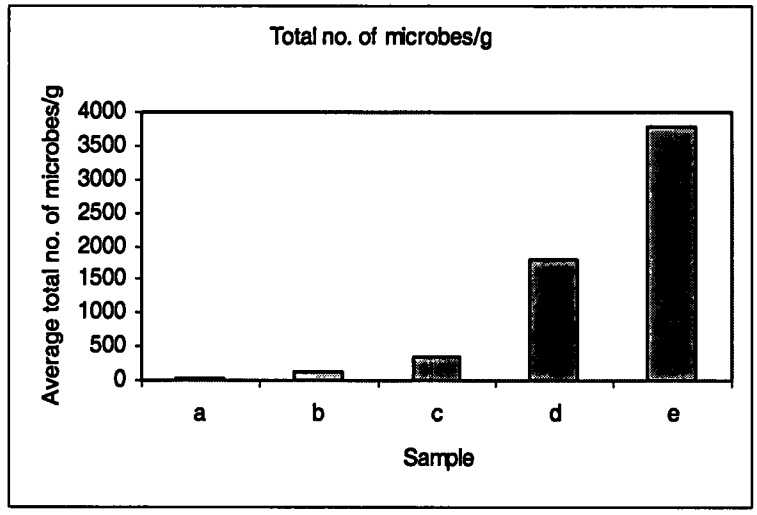

Fig. 1. Total number of microbes/g

(a) 340 W/3 min.+680 W/6 min., (b) FBD1st sect^{n} +680 W/5 min., (c) FBD 2nd sect^{n}+680 W/3 min., (d) FBD 3rd sect^{n} +680 W/1.5 min., and (e) FBD 4th sect^{n}

The results show that the microbial counts in the samples, that had been subjected to microwave energy alone, are much lower than in those samples that had been exposed to two-stage drying. The microbial count increased progressively with the reduction in time of exposure to microwave energy, during the two-stage drying process. The highest microbial count was seen in the samples that were subjected to FBD drying.

These results indicate that microwave energy has a direct impact on the microorganisms (Fig. 1). Microorganisms affect the keeping qualities of tea.

CONCLUSIONS

Trials on two-stage drying indicate that the quality of conventionally dried teas are better than that of two-stage-dried teas, both in terms of quality and flavour. However, microbial counts and PPO activity of microwave-dried teas are much less than that of conventionally dried teas.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the support and cooperation extended by the staff of the Technology Division, Tea Research Institute, and by the Managers and factory staff of St Coombs, Great Western and Watagoda Estates.

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