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Effect of Temperature on Optimum Fermentation Period for CTC Type Teas

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ABSTRACT. Fermentation is the most vital factor which influences the optimization of liquor characters of tea. However, the fermentation temperature is not always a constant. Therefore, it is important to investigate the relationship between the optimum fermentation period and the temperature to achieve the best quality CTC teas.

The main objective of this research was to establish the relationship between the temperature and the optimum fermentation period. Optimum fermentation time was estimated by the Chloroform method at different temperatures for CTC type teas. Two leaf standards from TRI 2025 clone were selected for the study. Results show an inverse relationship between optimum fermentation period and the temperature. This relationship provides a way to optimize CTC tea characters by predicting the optimum fermentation time for a given temperature.

INTRODUCTION

Tea is one of the most popular and oldest beverages in the world, obtained from carefully processed shoot tips of the tea plant. The tea plant has been cultivated for between two and three thousand years in South East China and more recently in South East Asia, Africa and South America. The two main varieties based on geographical locations, are *Camellia sinensis* var. *sinensis* and *Camellia sinensis* var. *assamica* (De Snell, 1973).

Different types of tea processing techniques are being practiced in Sri Lanka. Small quantities of green tea and large quantities of black tea are produced. In green tea, enzymes inactivate before leaf maceration whereas in black tea it occurs after the maceration of leaf. Pure Orthodox, Orthodox-Rotorvane and CTC/LTP are the main groups of black tea, presented in ascending order of maceration.

CTC type teas produce coloury and strong tea liquors due to severe maceration action in its rolling. Therefore, CTC teas produce a lager number of tea cups than other types, so that CTC teas are preferred to tea bags. Due to these reasons, the demand for CTC teas has increased markedly within the last few years compared to other types of black teas. The FAO Technical report (1989) reproduced in Table 1, information on the world tea production in 1987 and productions outlook to 1995. Table 1 shows an expected percentage increase of CTC tea production from 1987 to 1995 in Sri Lanka (218.7%), in developing countries (18.4%) and also in the World Total (13.1%) as against Orthodox teas.

A good demand is anticipated for a product, if its import requirement could not be fulfilled by the export availability. The following projection has been made by FAO regarding Export Availability (EA) and Import requirement (IR) of Black Tea in 1000 metric tons of made tea by 1995 and is presented in Table 2.

Table 2 implies that there would be a great demand for CTC teas in the future. There has been a definite trend towards CTC production and the demand for CTC teas also continues. FAO has projected a surplus production of 38 million kg of Orthodox Teas and a deficit of 6 million kg of CTC Teas, by 1995 (FAO, 1989).

Fermentation of made tea and its relevance

The favourable made tea character/s, such as colour of infused leaf and made tea, brightness, briskness, strength and colour of the liquor should be optimised to satisfy the market demand. Optimization of relevant character/s should be accomplished first. Then the total revenue needs to be analyzed for the best benefits of CTC Tea industry (Ranaweera and Samaraweera, 1991). Fermentation is the most crucial stage for the development of made tea characters. The most essential chemical reactions occur during fermentation. Thus, for achievement of optimum results, the period of fermentation should be optimised. Favourable chemical reactions occur very quickly in CTC process due to the severe maceration action. Therefore, accurate estimation of the optimum fermentation period is very important. Fermentation mainly depends on leaf variety and plucking standard, fermentation temperature and degree of maceration.

Table 1. The world tea production in 1987 and production outlook to 1995 (1000 metric tons).

	1987					1995				
	TOTAL	GREEN	BLACK	ORTHO	CTC	TOTAL	GREEN	BLACK	ORTHO	CTC
DEVELOPING COUNTRIES	2101	472	1629	829	800	2617	587	2030	977	1053
Far East	1074	34	1040	499	541	1302	42	1260	565	695
Bangladesh	40	-	40	10	30	65	-	65	15	50
India	673	7	666	170	496	820	10	810	185	625
Indonesia	134	25	109	109	-	150	30	120	120	-
Sri Lanka	213	2	211	205	6	257	2	255	235	20
Others	14	-	14	5	9	10	-	10	10	-
Africa	258	-	258	7	251	360	-	360	12	348
Kenya	156	-	156	2	154	210	-	210	2	208
Malawi	32	-	32	-	32	50	-	50	-	50
Rwanda	12	-	12	-	12	15	-	15	-	15
Tanzania	14	-	14	-	14	20	-	20	-	20
Zimbabwe	15	-	15	-	15	20	-	20	-	20
Others	29	-	29	5	24	45	-	45	10	35
Near East	170	-	170	170	-	200	-	200	200	-
Iran	25	-	25	25	-	50	-	50	50	-
Turkey	145	-	145	145	-	150	-	150	150	-
Latin America	48	-	48	48	-	70	-	70	70	-
Argentina	33	-	33	33	-	55	-	55	55	-
Others	15	-	15	15	-	15	-	15	15	-
ACP Countries	543	438	105	105	-	675	545	130	130	-
China(incl. Taiwan Prov.)	520	415	105	105	-	650	530	120	120	-
Oceania	8	-	8	-	8	10	-	10	-	10
DEVELOPED COUNTRIES	259	124	135	125	10	290	130	160	150	10
USSR	155	30	125	125	-	180	30	150	150	-
Japan	94	94	-	-	-	100	100	-	-	-
WORLD TOTAL	2360	596	1764	954	810	2907	717	2190	1127	1063

Table 2. Export availability and import requirement of black tea.

	ORTHODOX	CTC	TOTAL
Estimated export availabilities	665	427	1092
Projected import requirements	627	433	1060
Balance EA - IR	+38	-06	+32
Percentage difference	6.06	-1.39	3.02

Objective

The main objective of this study was to establish the influence of the temperature on the optimum fermentation period for CTC type teas.

MATERIALS AND METHODS

The experiment was carried out using a similar methodology as described by Samaraweera and Ranaweera (1988) except for the different levels of temperatures in test tubes. The second leaf of TRI 2025 clone was selected for estimation of optimum fermentation period using the Chloroform test as its suitability has been established by earlier work (Samaraweera and Ranaweera, 1988). Preliminary trials showed that the chloroform test for estimation of the optimum fermentation periods for CTC dhools at different levels of temperatures was satisfactory. The second leaf of TRI 2025 clone represented the leaf standard A on the Chloroform test in the temperature range that varied from 11.5 C to 49 C. Different temperatures obtained by a refrigerator incorporated with a fan taken from an Automatic Humidity Sensor and an oven. Readings were obtained at room temperature as well. Temperatures were measured by thermoprobes and a temperature indicator with five selector facility at an accuracy of 0.1 C.

Representative leaf for leaf standard B was found for this estimation, analyzing weight proportions of banji and 3 and a bud separately. Weight proportions could be calculated when 3 and a bud and banji is mixed at different ratios. The calculated values given in Table 3 imply that most representative leaf for standard B is banji leaf even at the ratio of 25 to 75 and 75 to 25. Therefore, the banji leaf was selected to estimate optimum fermentation periods at different temperatures for leaf standard B using Chloroform test.

Table 3. Percentages of weights of bud, first leaf, second leaf, third leaf, banji leaf and stem when 3 and a bud and banji mixed at different ratios.

3 and Bud	Bud	1st Leaf	2nd Leaf	3rd Leaf	Banji Leaf	Stem	Banji
0	2.5	-	-	-	90	7.5	100
25	3.4	2.7	5.7	6.5	67.5	14.2	75
50	4.3	5.4	11.3	13.0	45.0	20.8	50
75	5.3	8.2	16.9	19.6	22.5	27.4	25
100	6.2	10.9	22.6	26.1	-	34.1	0

RESULTS AND DISCUSSION

The temperature range studied was between 10 - 50 C. The scatter graph of temperature versus fermentation period is given in Figure 1. As shown by Figure 1, at lower temperatures, decreasing enzyme activity increases optimum fermentation time and the enzymes become inactive at very low (below 12 C) temperatures. Similarly, optimum fermentation time decreases with increasing temperature but within limits. As temperature increases beyond 40 C, enzyme activity reaches a peak and ceases beyond 50 C. The fermentation process being an action of enzymes on a substrate, one can expect the enzymatic activity to be operating in a narrow temperature range between 20- 50 C as shown in Figure 1. Also the optimum fermentation time appears to have an inverse power relationship with temperature within the operating temperature range of enzyme activity. Regression analysis showed an inverse relationship provides the best fit model.

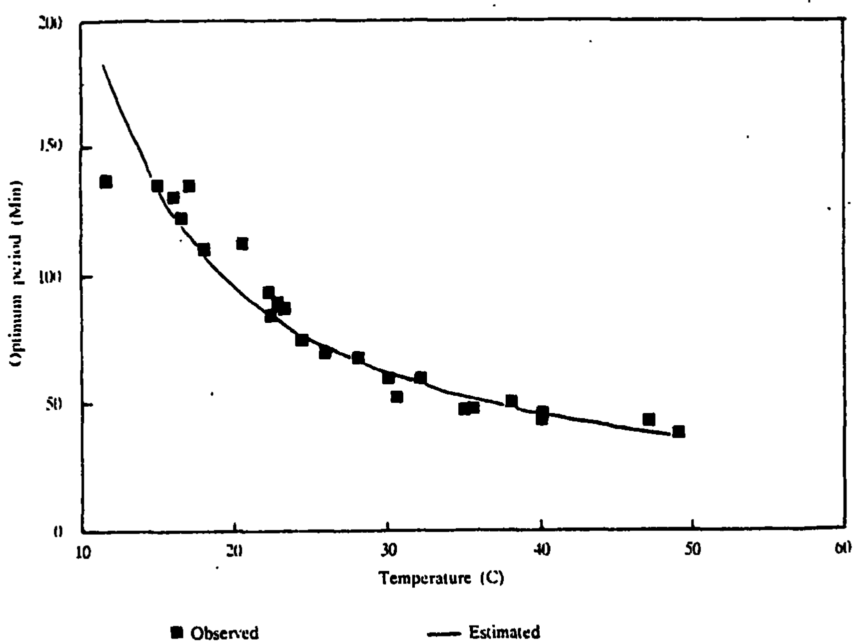

Figure 1. Effect of temperature on optimum fermentation period for CTC type teas.

The inverse relationship plotted along with the scatter is shown in Figure 1. The regression equation obtained is of the form given below with a r^2=0.957.

$1/t = 0.000577(T) - 0.001186$, where
t = fermentation time (min)
T = Temperature (C)

These results can be used to estimate the optimum periods of fermentation for leaf standard A (2 and a bud), at different levels of temperature within the range of 15 to 45 C. However, extrapolation of this equation is not recommended for any temperature outside the range of data.

Similarly, estimation of optimum period of fermentation was done for leaf standard B. However, the results obtained from the Chloroform test were not satisfactory enough for this purpose. Periods of fermentation varied markedly at a given temperature. Although results showed shorter fermentation periods when compared to standard A, these varied due to the degree of tenderness of the selected banji leaf. Since the bud is dormant in a banji shoot, leaf selection for Chloroform test was very difficult with uneven degree of tenderness. However, preliminary trials showed that the estimated fermentation periods for leaf standard A could be satisfactorily applied for leaf standard B as well. This is probably due to average degree of tenderness of banji leaf within the selected range being similar to that of the second leaf of TRI 2025 clone. This observation is supported by the particle size distribution of both leaf standards.

CONCLUSIONS

The optimum fermentation period for macerated tea dhool from CTC machine shows a significant inverse relationship with the fermentation temperature. The relationship between optimum fermentation period and fermentation temperature obtained in this study is applicable to dhool macerated by CTC machine using two leaves and bud, and equal mixture of three and bud and tender banji of TRI 2025 clone. This relationship shows better accuracy within the narrow temperature range of 15-45 C and could be used to determine the optimum fermentation time period required at a given temperature.

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