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EFFECT OF SIFTING OF DHOOL DURING FERMENTATION ON QUALITY OF MANUFACTURED BLACK TEA

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An investigation was carried out in the Talawakele region to find whether periodical sifting of dhools as opposed to the standard practice of non sifting could result in a better quality of tea. The results of this study revealed that teas manufactured in the normal manner produced better quality teas.

INTRODUCTION

Four important stages are involved in the manufacture of black tea. These are withering, rolling, fermentation (enzymic oxidation) and firing. Although each step in this process is complementary to one another, the most critical stage in the production of good quality black tea is fermentation as it influences the total quality and characters inherent in the respective teas.

During fermentation, all the chemical and biochemical reactions that were initiated during withering and rolling are accelarated to produce the compounds that give rise to colour, quality, character and flavour in made tea. Once the correct degree of fermentation is achieved the above reactions are arrested by firing. Although various methods have been proposed to evaluate the correct degree of fermentation, the sensory evaluation of the factory officer still remains the most reliable method.

The period of fermentation plays a critical role in producing the tea that is specific to a certain region during certain months of the year. For instance the seasonal teas in the Dimbula districts are exposed to a shorter period of fermentation during the months of January to April which preserves and bring) out the flavours that is formed during this season (i.e. the Dimbula seasons while a longer fermentation is practised during the rest of the year (off season) resulting in teas with liquory characters.

During fermentation, one of the practices that has been adopted by some estates is to sift the fermenting dhool at different time intervals to expose the dhool particles to a uniform degree of oxidation. However no investigation has been carried out to find the validity and usefulness of this practice. This study was initiated to assess chemically and organoleptically the quality of black tea made by sifting and non sifting the fermenting dhool.

EXPERIMENTAL

This study was carried out at St. Coombs factory, Talawakele (elevation 1382 m amsl) in the month of July. At the time of conducting this experiment the temperature prevalent in the factory was 21.5°C whilst the humidity level was 85%.

Flush (from mixed clones and seedling) collected from St. Coombs Estate was brought to the factory, well mixed and spread uniformly on large troughs for a period of 16 h for withering. A continuous supply of hot air (24°C) was passed through the troughs until the moisture content of the withered leaf was 55% which prevents the excess desiccation of cut leaf (dhool) as otherwise it would have an adverse effect on the subsequent stages of manufacture. The withered leaves were next passed through an orthodox Roller followed by a Rotorvane roller and subsequently seived through a rotary type roll breaker. The cut leaves (dhool) collected were next spread (5 cm) on a large cement table (3.6 x 7.2 m) for fermentation to take place. In this instance, the dhool spread was equally divided into eight parts (subdivided into 4 pairs) and each pair was subjected to a different treatment as the fermentation was in progress. The treatments were given in the following order:

T_1 — Dhools sifted every 15 min

T_2 — Dhools sifted every 30 min

T_3 — Dhools sifted every 60 min

T_4 — Dhools not sifted (control)

A metal spoon was used to sift and turn the dhools while the fermentation was in progress. The fermentation period was 2 h and 15 min and the above treatments were repeated at the specified time intervals and stopped when the fermentation period was complete. A sample of 1000 g was taken from each pair (i.e. 500 g from each subdivided lot of a pair) in separate firing trays and dried in the miniature dryer with an average inlet temperature of 124 °C and an outlet temperature of 92 °C. The dried samples were immediately collected into triple laminated aluminium bags and sealed under airtight conditions and labelled. The following estimations were done using standard procedures.

1. Moisture content (AOAC, 1970)
2. Flavour Index using gas chromatography (Yamanishi, et al, 1989)
3. Total polyphenols (Swain and Hills, 1959)
4. Percentage Theaflavins, Thearubigins (Roberts and Smith, 1963), total colour.
5. Unoxidised polyphenols (Swain and Hills, 1959).

RESULTS AND DISCUSSION

Since the rolled and cut leaf was thoroughly mixed prior to fermentation the order in which the dhool that was taken for firing would have been representative of the respective batches. Firing of the dhool was carried out in a miniature dryer, since using a large dryer would have created complications including the need for a large quantity of dhool and mixing of dhool of different batches inside the dryer. The performance and the condition of the miniature dryer is somewhat similar to that of a standard Endless Chain Pressure (ECP) dryer. Although there remains a small degree of difference in the conditions between the conventional dryers as opposed to the miniature dryer no treatment could have been conferred any advantage as all were fired in the same dryer (under the same conditions).

Moisture

Table I shows the percentage moisture in the different treatments. It is noticed that there is hardly any variation in moisture between treatments. This could be attributed to the relatively low temperature (21°C) and the high humidity level that was prevalent in the factory at the time of conducting this experiment which minimised the loss of moisture from the different treatments. This may be the reason for the moisture loss in the control and the 60 min sifting treatment remaining almost at the same level as in the other treatments.

Table I — *Moisture content of fermented dhools sifted at intervals*

Frequency of sifting	*Moisture content (%)*
15 min	49.73
30 min	50.31
60 min	50.80
No sifting	50.62

Flavour Index

Table 2 shows the results of the Flavour Index (Flavour Index= Linalool/ E-2—Hexanal). Yamanishi *et al.* (1989) have shown the existence of a direct relationship between the values of Flavour Index and quality of several teas obtained from the upcountry region of Sri Lanka.

TABLE 2 — *Flavour Index of made tea sifted at different time intervals during fermentation*

Frequency of sifting	*Flavour Index Linalool/ E - 2-Hexanal*
15 min	1.2312
30 min	1.1669
60 min	1.4159
No sifting	1.4174

It is apparent from the results that the Flavour Index shows an inverse relationship when the dhools are sifted at 15 and 30 min intervals whereas when sifted at 60 min the value is almost the same as when no sifting is done. Analysis of the levels of linalool and E-2-hexanal obtained using the gas chromatogragh showed that the former remained more or less constant in its levels while the latter showed a high degree of variation, where the 15 min treatment has the highest value while the control has the lowest level. Thus the values of the Flavour Index appear to favour non sifting as against sifting during fermentation.

Polyphenols

Table 3 shows the levels of total extractable (oxidised and unoxidised) polyphenols found in different treatments.

TABLE 3 — *Changes in levels of total and unoxidised polyphenols (mg g $^{-1}$) of tea brew with sifting frequency*

Frequency of sifting	*Total extractable (oxidised and unoxidised) polyphenols*	*Unoxidised polyphenols*
15 min	87.35	57.60
30 min	76.80	54.15
60 min	69.75	51.35
No sifting	66.25	49.80

The levels of the unoxidised polyphenols found in the respective treatments show a direct relationship to the frequency of sifting per unit hour.

Other than in seasonal upcountry teas and Nuwara Eliyas, if a high percentage of unoxidised polyphenols is detected in the dhools immediately after fermentation but prior to firing it is an indication that satisfactory conditions were not maintained during the manufacture for the polyphenol oxidase enzyme to effectively convert unoxidised polyphenols to oxidised polyphenols. The present study indicates a higher percentage of unoxidised polyphenols in the sample sifted every 15 min as against the control. The factors which determine the effective conversion of unoxidised to oxidised polyphenols are the pH, length of fermentation and temperature. As the first two factors are common to all treatments, temperature appears to be the determining factor. In this instance, it is likely that the heat generated as a result of some exothermic reactions was dissipated due to the sifting of dhools which in effect decreased the rate of enzyme activity leaving a high percentage of unoxidised polyphenols unreacted in the treated samples. Conversely it is expected that the total extractable polyphenols (including unoxidised and oxidised polyphenols) to remain more or less at the same level in the control as in the 15 min sifting treatment. However, the percentage of total extractable polyphenols is less in the control than in the treated sample. On close examination it is seen that despite a high percentage of unoxidised polyphenols that are being oxidised in the control, the high rate of catalytic activity of the enzyme has oxidised the polyphenols to a greater degree thereby forming a complex reactive polymerised mixture of oxidised polyphenols which, in effect, had reacted more strongly with the insoluble matrix of the fermenting dhool as against the others and be permanently immobilised resulting in the low values seen.

Theaflavins (TF), Thearubigins (TR)

Soluble oxidised polyphenols formed during black tea manufacture is responsible for contributing to the colour and quality observed in a black tea brew. Roberts and Smith (1961, 1963) who have exhaustively studied the polyphenols have broadly categorised the oxidised polyphenols into two groups i.e. Theaflavins (TF) and Thearubigins (TR) based on certain physical properties they displayed. These properties included solubility and optical density.

A good tea is one that contains a delicate balance of some important constituents which determine certain characters in tea. For instance TF contributes to quality and brightness while TR contributes to colour, body and strength ; a high level of TF generally contributes to a good quality tea while a high level of TR results in a tea of poorer quality. Results obtained for TF and TR in the present work are given in Table 4. Except for the 15 min sifting treatment the levels of TF's in the other treatments appear to have reached a plateau.

TABLE 4 — *Percentage TF, TR and total colour of tea brew with frequency of sifting*

Frequency of sifting	*Theaflavin (TF)*	*Thearubigin (TR)*	*Total colour*
15 min	1.035	15.68	3.50
30 min	1.220	15.96	3.75
60 min	1.193	16.46	3.50
No sifting	1.220	16.18	3.69

The amount of TR formed in the control is only marginally higher than that formed in the 15 min sifting treatment. Such levels would not adversely affect quality as TR also contributes to body and partly to the strength of black tea.

Among the treatments the highest percentage of extractable TR was in the 60 min sifting treatment. The lower level of TR in the 15 and 30 min sifting treatments may be due to the lower level of polyphenol oxidase activity as a result of loss of temperature owing to the sifting of the fermenting dhool samples. On this basis a higher percentage of TR should be expected in the control compared to the other treatments. The lower percentage of TR in the control is possibly due to the high rate of catalytic activity of the enzyme as a result of a temperature build up in non-sifting which results in some of the polyphenols undergoing a very high degree of polymerisation.

TR's being integral components of oxidised polyphenols are immobilised on the insoluble cellulose matrix during the manufacture.

The colour observed in black tea results from a range of products formed by the reactions that takes place during manufacture. These coloured products include mainly TF and TR's formed by the oxidation of polyphenols (during fermentation) as well as others formed by the interactions between amino acids and sugars. This explains the reasons for the weak liquoring characters of Nuwara Eliya teas where the manufacturing condition involves hardly any fermentation. Conversely the strong liquoring characters observed in the low country teas is attributed to the longer period of fermentation to which those teas are subjected during the black tea manufacture. This results in the near total oxidation of the polyphenols to give rise to the groups of compounds mentioned earlier. From Table 4 it is noticeable that the values for total colour are more or less constant indicating that they essentially fluctuate within a restricted range.

Thus it could be assumed that despite the likelihood of an existence of a difference in the colour intensity from one treatment to another this is not uniformly apparent in this instance owing to the marginal difference in the colour between different samples. This could be attributed to the low sensitivity in the procedures adopted for the above study.

CONCLUSION

From the above study, information has been gathered on the effect of sifting practices on the quality of made tea.

For instance the values of flavour index for the four treatments have shown that more desirable teas are manufactured if fermenting dhool is not sifted during fermentation. The levels of TF and TR found in the different treatments confirm the above conclusion. Organoleptic assessment further substantiate the chemical evaluation.

It is shown that teas manufactured in the Talawakele region where the temperature is 21.5°C and the humidity about 85 per cent, gives rise to a more desirable product if the dhool is not sifted during the fermentation stage. However it should be noted that the physical conditions that are prevalent at the place and time of manufacture are key factors in determining the appropriate method to adopt during the fermentation stage.

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