THE INFLUENCE OF THE DEGREE OF WITHER IN ROTORVANE MANUFACTURE OF HIGH-GROWN LEAF

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This investigation was carried out to determine the effect of the degree of wither on made tea characteristics of mixed rotorvane-orthodox teas. Information has also been sought on the influence of the wither on leaf temperatures during rolling and fermentation as well as on dhool and grade outturns.

Indications are that the softer withers produce brighter infusions and more coloury liquors when compared with the harder withers. Strength and quality of liquors were not markedly different for the three different withers investigated. Valuations did not differ greatly but it appears as though the teas from soft withered leaf were priced slightly higher.

The dhool production during rotorvaning was higher for the hard withered leaf. Leaf temperatures during rolling and fermenting were not significantly different for the different withers, neither were grade outturns.

Introduction

Experiments were conducted to determine the influence of the degree of wither in rotorvane manufacture soon after the Rotorvanes were introduced to Ceylon. No definite conclusions were reached but it was noted that softer withers on the whole tended to make the tea blacker and resulted in lower rolling temperatures (Keegel 1964).

The influence of the degree of wither in relation to rotorvane manufacture is of particular interest because it has so far not been thoroughly investigated. In general, the practice adopted with orthodox manufacture has also been employed in rotorvane manufacture and consequently withers ranging from 40–48% made tea to withered leaf have been observed in factories where Rotorvanes are in use.

With orthodox manufacture, a great deal of latitude is permissible in the type of wither. It is possible to produce teas of very different character to meet the requirements of one market or another by the use of different rolling techniques to suit the type of wither taken. For instance, soft withers coupled with light rolling are employed in the low country to produce flowery grades and medium to hard withers with hard rolling pressures are generally preferred for the production of high grown quality teas. Whether this same latitude is permissible in rotorvane manufacture is not yet known. It seems possible, however, that different withers may be suited to different combinations of vanes and end-plates.

The present study was initiated in order to determine the optimum degree of wither for the programme of mixed orthodox-rotorvane rolling with the rotorvane being introduced early into the rolling process. The results obtained would be applicable under the conditions stipulated in the experimental design but may be found to be otherwise under different operating conditions.

Experimental design

The machine used for the experiment was an 8-inch series B model Rotorvane, the rotor shaft of which had eight forward-pitched vanes and one reverse-pitched vane, the latter being placed centrally. It was fitted with an Iris end plate and throughout the trial it was used in the full open or minimum pressure position. The position of the Iris end plate corresponded to the covering of the rotorvane discharge end by 61% of the total area. The rotor shaft of the machine was operated at a speed of 36 rpm. A randomized block experimental design was used in the investigation.

Procedure

The experiment which was replicated eight times, was conducted during April/May 1965. On each day, three different withers corresponding to about 42, 45 and 48 OTMT/WL were studied. The method of rolling was identical to that of programme 1 outlined by de Silva and Sanderson (1965). According to this programme, the withered leaf was pre-conditioned for a period of ten minutes in a 45" orthodox roller under very light pressure. This was followed by one pass through the Rotorvane. After aeration a rotorvane dhool was extracted. The bulk was given two orthodox rolls of 30 minutes duration with 7 on 3 off method of pressure application. The degree of pressure was regulated to obtain about 7% big bulk for each of the treatments.

The 45" roller used for the pre-conditioning rolls had a Keegel table. The second roll (Orthodox) was carried out in a 32" roller having crescent battens and a medium Rettie cone and the third roll (Orthodox) was carried out in a 34" roller having M & S battens and a fadeaway cone.

All dhools were extracted in one operation using a vibratory roll breaker fitted with Nos 5 and 6 meshes. Throughout the trial the period of fermentation for all three treatments ranged from 2 hours 30 minutes to 3 hours 20 minutes corresponding to a charging interval of 50 minutes. To obtain better control of the period of fermentation representative samples weighing 22½ lb, corresponding to each of the treatments and taken proportional to their dhool and big bulk outturns were fired in an experimental drier. Firing in the experimental drier has been assumed to be in no way different to that of a commercial drier (Keegel 1962).

The experimental drier was operated at a firing temperature of 195°F and at an exhaust temperature of about 125°F. Grading was carried out using hand sieves. The BOP and BOPF grades were sent to panels of tasters in Colombo and London for evaluation. In addition, triplicate samples were sent to the Institute's tea taster for the same purpose. Tasters were requested to evaluate the teas on the basis recommended by Keegel (1959).

Results

Results obtained with respect to moisture contents of rolled leaf, intakes, dhool outturns, grade outturns and leaf temperatures during rolling and fermentation are summarized in Table 1 .

TABLE 1—*Effect of degree of wither on dhool outturns, grade outturns and leaf temperatures-Averages obtained in 8 replicates of the trial*

Factor investigated	MEANS Soft wither	Medium wither	Hard wither	Significant differences P=0.05	P=0.01
Dry matter content of rolled leaf ...	40.7	43.4	46.9	1.5	1.8
Intake of RV in lb/hr ...	1181	1125	1130	n.s	n.s
Intake in lb/min/revolution ...	0.547	0.521	0.523	n.s	n.s
1st dhool outturn (RV) percentage ...	50.0	52.0	53.3	2.4	2.9
2nd dhool outturn (Orth) percentage...	22.4	24.5	23.2	n.s	n.s
3rd dhool outturn (Orth) percentage...	17.5	14.2	14.8	n.s	n.s
Big bulk percentage ...	7.1	6.9	6.4	n.s	n.s
Loss in rolling percentage ...	3.0	2.4	2.4	n.s	n.s
Ambient dry bulb temperature (°F) ...	65.6	66.7	66.1	n.s	n.s
Ambient wet bulb temperature (°F) ...	62.9	63.4	63.0	n.s	n.s
Temperature of Preconditioned leaf (°F)	72.6	73.9	74.3	n.s	n.s
Temperature of Rotorvaned leaf (°F)...	80.0	79.9	82.1	n.s	n.s
Temperature of leaf after aeration (°F)	78.0	77.9	79.9	n.s	n.s
Temperature of 1st dhool (°F) ...	73.7	73.7	73.3	n.s	n.s
Temperature after 2nd roll (°F) ...	81.4	83.7	84.1	n.s	n.s
Temperature of 2nd dhool (°F) ...	76.0	73.6	73.1	n.s	n.s
Temperature after 3rd roll (°F) ...	84.7	83.9	81.3	n.s	n.s
Temperature of 3rd dhool (°F) ...	75.9	74.0	73.0	n.s	n.s
Percentage of BOP outturn ...	58.1	59.0	57.5	n.s	n.s
Percentage BOPF outturn ...	24.2	24.2	25.6	n.s	n.s
Percentage Dust No. 1 outturn ...	9.2	9.1	8.9	n.s	n.s
Total Main Grades percentage ...	91.5	92.3	92.0	—	—

Analysis of variance was carried out on the evaluations given by the TRI taster and panels of tasters in Colombo and London. The results are summarized in Table 2.

Discussion

1—*Intakes*

The intake of the Rotorvane was kept more or less constant throughout the trial to correspond to a $\emptyset$ value of about 0.5 (see de Silva 1965) for all three withers. This was made possible by the incorporation of a rubberized conveyor belt arrangement for feeding the leaf.

2—*Dhool outturns*

The results presented in Table 1 indicate that the production of dhool during rotorvaning of leaf is influenced by the degree of wither. A mean increase of about 3.3% dhool in the first pass through the Rotorvane using hard withered leaf was observed when compared to soft withered leaf. This increase was found to be significant ($P<0.01$). However, a significant difference in the production of dhool was not observed between medium and hard withered leaf but there are strong indications to show that the production of dhool is higher for medium withered leaf than for soft withered leaf. It is also interesting to note that the mean dhool outturn of 52.0% observed in the case of medium withered leaf compares very well with similar results published earlier (de Silva 1965).

3—*Leaf temperatures*

No significant variation of leaf temperatures during all stages of rolling and fermentation was observed in relation to the degree of wither. There are strong indications, however, to show that the temperature of rotorvaned leaf is higher for hard withered leaf when compared with both medium and soft withered leaf.

TABLE 2—*Effect of the degree of wither on made tea characteristics—Mean evaluations given by tasters on the basis recommended by Keegel (1959)*

Characteristic	Grade	Tasters' panel	No of observations	Mean evaluations			Significant difference		Level of significance of taster x wither interaction
				Soft wither	Medium wither	Hard wither	P=0.05	P=0.01	
Brightness of Infusion	BOP	TRI	24	5.25	5.25	5.08	n.s	n.s	–
		Colombo	29	5.34	5.10	4.93	n.s	n.s	n.s
		London	46	6.16	5.46	5.50	0.29	0.40	n.s
	BOPF	TRI	24	5.38	5.21	5.04	n.s	n.s	–
		Colombo	29	5.31	5.24	5.10	n.s	n.s	n.s
		London	46	5.87	5.73	5.39	n.s	n.s	n.s
Colour of liquor	BOP	TRI	24	5.25	5.55	5.08	0.30	0.40	–
		Colombo	29	5.41	5.17	4.90	0.19	0.27	n.s
		London	46	5.53	5.28	4.61	30	0.41	$P < 0.05$
	BOPF	TRI	24	5.54	5.42	5.17	n.s	n.s	–
		Colombo	29	6.03	6.24	5.93	n.s	n.s	$P < 0.01$
		London	46	6.17	6.07	5.66	0.35	0.48	$P < 0.05$
Strength of liquor	BOP	TRI	24	5.21	5.42	5.25	n.s	n.s	–
		Colombo	29	4.86	4.86	4.83	n.s	n.s	$P < 0.01$
		London	46	5.42	5.25	4.82	0.38	0.53	n.s
	BOPF	TRI	24	5.17	5.00	5.29	n.s	n.s	–
		Colombo	29	5.52	6.03	5.93	0.42	0.58	$P < 0.01$
		London	46	6.24	6.34	5.93	n.s	n.s	n.s
Quality of liquor	BOP	TRI	24	5.38	5.50	5.33	n.s	n.s	–
		Colombo	29	5.14	5.07	5.17	n.s	n.s	n.s
		London	46	5.11	4.95	4.84	n.s	n.s	n.s
	BOPF	TRI	24	5.12	5.00	5.21	n.s	n.s	–
		Colombo	29	4.66	4.76	5.07	n.s	n.s	$P < 0.01$
		London	46	5.45	5.51	5.16	n.s	n.s	n.s
Valuation	BOP	TRI	24	207.07	209.5	208.7	n.s	n.s	–
		Colombo (cents)	29	230.7	227.3	222.2	n.s	n.s	n.s
		London (pence)	34	51.45	50.22	50.01	1.17	1.61	n.s
	BOPF	TRI	24	225.5	224.6	228.1	n.s	n.s	–
		Colombo (cents)	29	229.5	227.7	230.8	n.s	n.s	n.s
		London (pence)	33	55.30	55.11	54.29	n.s	n.s	n.s

.4—*Grade outturns*

It was observed that the outturns of three main grades are not influenced by the degree of wither. The total main grade outturn in each case was about 92%.

.5—*Made tea characteristics*

(a) *Brightness of infusion*

The TRI tea taster and Colombo panel of tasters did not report any significant difference in the brightness of infusion of both BOP and BOPF grades corresponding to the three different withers. However, the Colombo panel of tasters showed a strong preference for the brightness of infusion for the BOP grade corresponding to the soft withers as against those corresponding to the hard withers.

According to the London panel of tasters, the brightness of the infusion of the BOP grade corresponding to the soft withers was significantly superior to those of both medium and hard withers. They did not find any significant difference between medium and hard withers. In the case of the BOPF grade, they showed a strong preference for the brightness of the infusions of both soft and medium withers as against those corresponding to hard withers even though these differences were not significant.

From what has been revealed, it can be concluded that hard withers are not conducive for the production of bright infusions. Whether a soft wither will yield a brighter infusion than medium withers in relation to the main grades is still unproven. The indications are, however, that it is best to use soft withers, especially when teas are sold on the London market.

(*b*) *Colour of infusion*

For the BOP grade, the TRI taster and the Colombo and London panels found the colour of teas corresponding to hard withers the worst. The TRI taster preferred the teas from medium withered leaf to those from soft withered leaf, whilst the Colombo panel preferred teas from soft withered leaf to those from medium withered leaf. The London panel showed a strong preference for the BOP from soft withered leaf to those from medium withered leaf. In this case, the taster x wither interaction was significant ($P<0.05$), whilst variation due to withers and tasters were both significant ($P<0.05$). The interaction could, therefore, very well be ignored and it could be assumed that all six tasters from the London panel were in agreement as to their preferences for the soft and medium withered leaf, over hard withered leaf.

For the BOPF grade, the TRI taster and Colombo panel did not detect any significant difference between teas corresponding to the different withers. The TRI taster showed only a strong preference for both soft and medium withered leaf over hard withered leaf. Evaluations by the Colombo panel of tasters indicated a taster x wither significant interaction ($P<0.01$).

The London panel of tasters preferred the BOPF grade corresponding to both soft and medium withers to that corresponding to hard withers. This result must be considered in relation to the significant ($P<0.05$) taster x wither interaction. Three of the London tasters preferred soft and medium withers to hard withers, two tasters preferred soft withers to both medium and hard withers, whereas yet another preferred hard and medium withers to soft withers.

From the above it is seen once again that the employment of hard wither is not conducive for the improvement of the colour of the liquors of rotorvane teas. Like in the case of the brightness of the infusion, no conclusions could be drawn with regard to medium and soft withers.

(c) *Strength of liquors*

The TRI taster did not find any significant difference between strength of liquors of both BOP and BOPF grades corresponding to the different withers. The Colombo panel did not report any significant difference in relation to the BOP grade. In the case of the BOPF grade, the Colombo panel of tasters found the strength of the liquors of both medium and hard withered leaf significantly superior to that of soft withered leaf. The Colombo panel evaluations showed a taster x wither interaction ($P<0.01$) for both BOP and BOPF grades. Two of the four tasters in the Colombo panel found no significant difference between the strength of liquors of both BOP and BOPF grades corresponding to the different withers. Of the other two tasters, one preferred the strength of the BOP grade corresponding to the soft withers as against both medium and hard withers whereas the other preferred the strength of the BOP grade of hard withered leaf to the rest. With respect to the BOPF grade, these two tasters preferred the strength of liquors of both medium and hard withered leaf to that of soft withered leaf.

The London panel of tasters found the strength of liquors of the BOP grade corresponding to the soft and the medium withers significantly superior to that of the hard withered leaf. They, however, did not find any significant difference between the strength of liquors of the BOPF grade.

From these results it is difficult to draw firm conclusions with regard to the suitability of any particular wither for the development of strength of liquors of rotorvane teas. However, it appears that nothing will be lost by the employment of soft and medium withers.

(d) *Quality of liquors*

The TRI taster as well as the Colombo and London panels found no significant difference between the quality of liquors of both BOP and BOPF grades corresponding to different withers. This result is quite in agreement with our present ideas on the development of quality. It should be noted that leaf temperatures during all stages of rolling and fermentation were well below the highest permissible temperature for the development of quality. Failure by the tasters to detect any differences with regard to quality is, therefore, quite understandable. In passing, it must be noted that for the BOPF grade evaluations given by the Colombo panel of tasters yielded a taster x wither interaction significant at $P<0.01$.

(e) *Valuations*

Valuations given by the TRI taster and the Colombo panel for the BOP grade were not significantly different for the different withers. Although the valuations given by the Colombo tasters were not significantly different at $P=0.05$, there are strong indications that soft and medium withered leaf will realize better valuations than hard withered leaf for the BOP grade. This tendency was shown by all the four tasters of the Colombo panel. The London panel valued the BOP grade of the soft withered leaf significantly higher than those corresponding to medium and hard withered leaf. Valuations given for the BOPF grade of all three treatments by all the tasters (TRI, Colombo and London) were not significantly different from one another.

Summary

The results indicate that a slightly higher dhool outturn in the first pass through the Rotorvane is to be expected as the hardness of the wither is increased. Substantial differences of leaf temperatures during rolling and fermentation were not observed with different withers. The degree of wither does not significantly influence the grade outturns.

Made tea characteristics are to some extent governed by the degree of wither. Brighter infusions and coloury liquors are to be expected with soft and medium withers when compared to hard withers. Strength and quality of liquors appear to be un-influenced by the degree of wither. Teas from soft and medium withered leaf can also be expected to realize slightly better valuations than teas from hard withered leaf.

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