Evaluation of True-to-Type Main Grade Percentage of Black Tea according to Different Roll Breaker Meshes by Sieve Analysis

M.P.A. SUSANTHA[1], G.L.C. GALAHITIYAWA[2], K.G.M.C.P.B.GAJANAYAKE[1] and W.M.U.A.B.MARAPANA[2]

[1]*Department of Plantation Management, Faculty of Agriculture and Plantation Management, Wayamba University of Sri Lanka, Makandura, Gonawila (NWP), Sri Lanka.*
[2]*St. Joachim Factory, Technology Division, Tea Research Institute, Low Country Station, Rathnapura, Sri Lanka.*

ABSTRACT

Production of high quality tea grades with minimum undersized and oversized particles, with lowest possible cost and minimum colour deterioration is of prime objective of an efficient black tea processing system. In this context this study was carried out to investigate the effect of roll breakers, different mesh sizes on black tea manufacturing process in low country of Sri Lanka. The roll breakers with mesh No. 4 and mesh No. 3 and 4 combination were selected for this study. The study was done as two batches. Mesh No. 4 roll breaker was used as control batch and No. 3 and 4 combination was used as experiment batch. In manufacturing process OPA, OP_1, OP and Pekoe grades were selected to investigate the true-to-type grade percentage. Especially OPA and Pekoe grades were significantly difference among the experiment batch and control batch. However, all grades were recorded true-to-type quantity of made tea in experiment batch compare to the control batch. Results of the study revealed roll breaker with mesh No. 3 and 4 combination is better than the roll breaker with mesh No. 4 for black tea manufacture in low country.

KEY WORDS: Black Tea Processing, Mesh Size, Roll Breakers, True to Type.

INTRODUCTION

Tea, *Camellia sinensis* (L). O. Kuntze is the major export agricultural crop in Sri Lanka, with annual production of 308.1 million kilograms in year 2003 (Anon, 2004) and from which 95 percent is exported. Even though tea earns 682 million dollars (Anon, 2003), it occupies only 3 percent of the total extent of land in Sri Lanka. Sri Lanka as the third biggest tea producing country globally, is one of the world's leading exporters with a share of around 19 percent of the global demand. Today Sri Lanka, tea has dispersed nearly 106 countries. At the same time country is exposed to fierce competition from more than 60 tea producing countries (Anon, 2005). The major competitors are Kenya, China and Indonesia. An added advantage over competitors can be gained through increasing the productivity, improving the quality of made tea and value addition.

Five principal operations are involved in the processing of tea leaves, *viz.* (a) Withering: Extraction of part of the moisture from green leaf; (b) Rolling: Maceration of the withered leaf; (c) Drying: Extraction of the balance moisture from the processed leaf; (d) Shifting: Grading of made tea according to the particle size; (e) Packaging: Packaging suitable for dispatch (Jayatunga, 1999).

Roll breaker is essentially a sifter where the leaf rolled in a rolling machine is sifted for the purpose of separating smaller size particles from the leaf bulk. Therefore, the roll breaker consists essentially of a mesh of a particular size, mounted on a frame with facility to rotate or oscillate (vibrate) in such a manner to help separation of fines (Samaraweera, 1986).

The reciprocating roll breaker is found to be preferable for low country orthodox manufacture (Jayatunga, 1999). The sizes of the mesh to be used depend on the requirements of grades. The percentage dhool out turn by itself does not indicate the severity of rolling process. It also connected to the mesh number and wire size, and the efficiency of extraction. The ultimate percentage of different grade out turns of the uncut product depends on rolling and roll breaking operation. Main grades of tea should not contain any significant amount of cut pieces due to two reasons. *viz.* loss of appearance and the exposure of fresh surfaces for infusion, leading to a raw character in the liquor. Experimental evidence show that a given rolling program with dhool extracted over different size meshes produced significantly different grade out turns. The choice of correct size roll breaker mesh or mesh combination is therefore the basic and simple answer for attaining the desired grade composition of the products. Tea grading is essentially a classification of the product in term of particle size, shape and cleanliness.

When particles are heterogeneous in size, they are sifted on a mesh and those particles with smaller cross section than the aperture size of the mesh are allowed to go through, whereas the balances remain on the mesh. When particles extracted between meshes, some over size and some under size particles are therefore inevitable (Samaraweera, 1986).

In this process of production of high quality tea grades, it is essential to minimize the under size particles and over size particles in the tea grades. It is fulfilled by resifting the under size particles and over size particles. In this practice black colour of the product get deteriorated resulting drop in quality and rise in the cost of production.

Adoption of standards in the particle size distribution of grades would help to define the efficiency of sorting technique. Roller and roll-breaker efficiency too could be defined and roll-breaking operation could be geared to minimize over size particles in the dhools. The benefit that would accrue from this is that size reduction processes such as cutting and nipping of over size particles of fired tea during grading, could be minimized (De Silva, 1972).The average particle size of a poly disperse mixture could be computed from the distribution of particle sizes. Sieve analysis techniques had been used to generate the distribution of particle sizes of black tea grades. An Endecott Sieve Shaker is used to sieve analysis (Mohamed *et al*, 2004).

An evaluation of the results of roll breaker mesh and roll breaker mesh combination with a sieve analysis of black tea would identify a suitable roll breaker for this matter.

MATERIALS AND METHODS

This experiment was carried out at St. Joachim factory (22.1m amsl) managed by Tea Research Institute low country Station in Rathnapura during January 2006 to July 2006.

Green leaf was loaded in two withering troughs the size of 6 feet *70 feet. After 12 hours of withering, green leaf became withered leaf. The withered leaf in each trough was weighted separately and 550 kg of withered leaf was taken from each trough. These withered leaves were loaded into 275 kg capacity of two precondition rollers. The withered leaf was rolled for 20 minutes. Then it was sieved using roll breaker with mesh No. 4 and the first dhool was extracted from each roller. This dhool was weighted and spread on the fermentation table for fermentation.

Rests of preconditioned leaves were rolled in second roller. Rolling time was managed to 20 minutes, with applying 5 minutes on/off pressure. After 20 minutes rolling, leaf was discharged and fed into roll breaker with mesh No. 4 to extract the second dhool. This second dhool was weighted and spread on the fermentation table. Then third dhool and fourth dhool were extracted from roll breaker with mesh No. 4 followed by the above second roller procedure and rest of rolled leaves were rolled in fifth roller and it was taken as the big bulk for control batch. Experiment batch also followed above procedure with roll breaker with mesh No. 3 and 4 combination instead of the roll breaker with mesh No. 4 for the dhools extraction.

Wet dhool was dried by Endless Chain Pressure (ECP) dryer. The firing order was third dhool, first dhool, second dhool, fourth dhool and big bulk in each batch. Dhool was fired at 21 minutes in the dryer. Dryer inlet temperature and exhaust temperature were maintained in 230^0F and 130^0F respectively. After firing, wet dhool was called dry dhool or made tea. These dry dhools were passed through the Fiber Mat Extractor except the first and second dhools to eliminate the fiber in made tea. Then it was passed through the Middleton Stalk Extractor to separated into three fractions according to there particle sizes as large, medium and small fraction. At there, both first and second dhools were taken together in Middleton Stalk Extractor. Then Third and fourth dhools were taken together and finally big bulk was taken.Then the large fractions of each dhool were winnowed separately by winnower. Winnower has six boxes separated from each other. At the winnowing, large fraction of first and second dhools were passed together through the winnower. Then third and fourth dhools were passed together. Finally big bulk was passed. The fraction which was collected separately from the first three boxes of winnower of each dhool was sieved by Miche Sifters with mesh No. 4, mesh No.6 and mesh No. 8 in sequences.

Made tea particles that couldnot pass through the Miche Sifter with mesh No. 4 was taken as unrolled particles. Rest of tea particles which were passed through the Miche Sifters with mesh No. 4 were fed into Miche Sifters with mesh No. 6 and continued sieving. Then made tea which could not passed through the Miche Sifters with mesh No. 6 was taken as OPA grade. Rest of the tea particles were loaded to Miche Sifter with mesh No. 8 to continue the sieving. Finally tea particles which were passed through the Miche Sifter with mesh No. 8 was taken as OP and rest of tea particles was taken as OP_1 grade. At the end, these OP and OP_1 grades were evened further by Middleton with mesh No. 4 and 7 combinations. The unrolled particles and OPA grades were evened separately by Middleton with mesh No. 4 and 9 combination and taken Pekoe grade and evened OPA.

The shaking machine was capable of accommodating ten sieves. These were nested one above the other, so arranged that any one sieve had screen openings larger than the ones below. A solid pan (receiver) was placed under the bottom sieve. A lid was placed on the top most sieve and the whole assembly was fixed tightly to the vibratory platform of the sieve shaking machine. The sieve shaking machine was capable of vibrating the test sieves electro-magnetically at 50 Hz and their movement combined vertical motion with a rotational action. This gave thorough stratification and caused the presentation of the particles at all angles to the sieve apertures. The shaking machine had a built-in control with a scale reading from 0 to 10 with varying intensity of vibration, and a 0-to-60-min. time switch. 100 g of replicate samples having common origin were sieve shaked at the maximum intensity of vibration for a period of 10 minutes. This standardized method of fractionating was adopted in all the OPA, OP, OP_1 and Pekoe grades of both experimental and control batches.

The weights of tea particles, which were in sieve pans, were entered in Ms Excel sheet and calculated the total average weight of six replicates in two batches. Then according to the data, four graphs of particle size distribution of these four grades were plotted. Further, data were analyzed by Minitab 13.

RESULTS AND DISSCUSSION

Assessment of Particle Size Distribution

Six replicates were carried out in this investigation. Data were taken for each grade for each replicate of the control and experiment batches.

There were properly distributed curves for both batches of OPA grade. The highest peak value for average weight of the grade was shown on the experiment batch (33.86g/100g) over the control batch (30.86g/100g). There were considerable different between peak values of both batches (Figure 1).

Normal distributed curves were obtained for both batches of OP_1 grade. The highest peak value for average weight of the grade was shown on the control batch (39.70g/100g) over the experiment batch (39.18g/100g). But there were no considerable different between peak values of both batches (Figure 2).

Normal distributed curves were obtained for both batches of OP grade and the highest peak value for average weight of the grade was shown on the experiment batch (48.68g/100g) over the control batch (47.84g/100g). But there were no considerable different between peak values of both batches (Figure 3).

There were properly distributed curves for both batches of Pekoe grade and the highest peak value for average weight of the grade was shown on the experiment batch (38.71g/100g) over the control batch (34.17g/100g). There were considerable different between peak values of both batches (Figure 4).

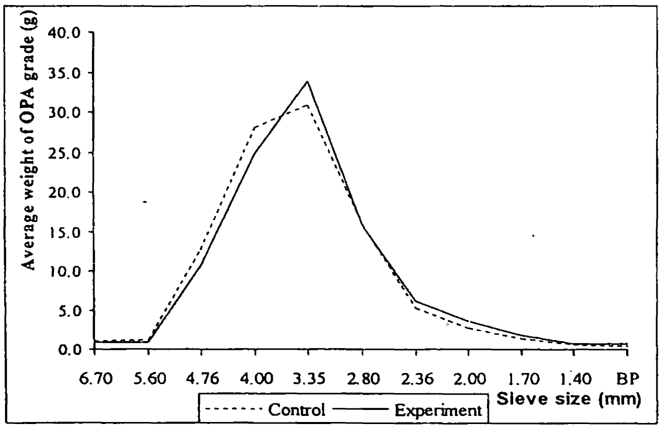

Figure 1- Particle size distribution of OPA grade in Control and Experiment batches

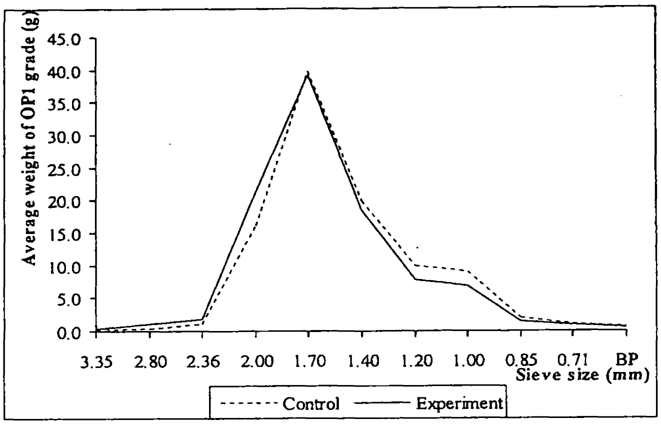

Figure 2-Particle size distribution of OP_1 grad Control and Experiment batches

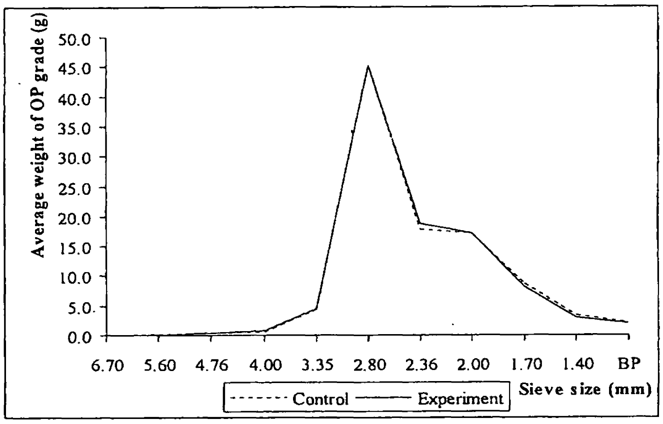

Figure 3 - Particle size distribution of OP grade in Control and Experiment batches

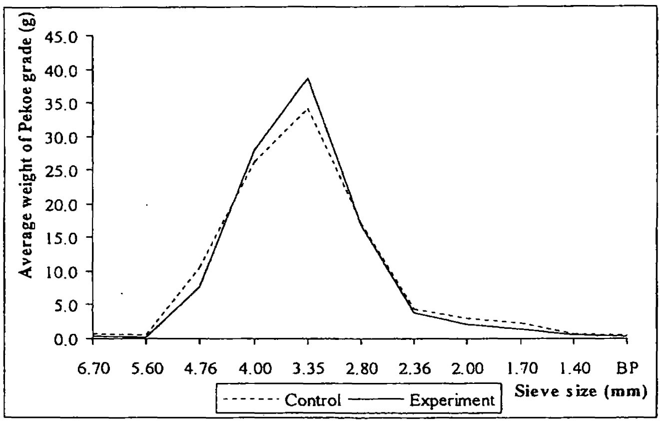

Figure 4 - Particle size distribution of Pekoe gradein Control and Experiment batches

Assessment of True-To-Type Grade Percentage

There were significant differences between the experiment batch and control batch for the true-to-type percentage of OPA grade as well as true-to-type percentage of Pekoe grade. There were not significant differences between the Experiment batch and Control batch for the true-to-type percentage of OP_1 grade as well as true-to-type percentage of OP grade (Table 1).

Table 1- Mean of true-to type grade percentage:

Grade	Experimental Batch	Control Batch
OPA	92.14[a]	89.43[b]
OP1	86.92[a]	86.70[a]
Pekoe	95.93[a]	89.34[b]
OP	75.52[a]	75.36[a]

Means in a row followed by the same letter are not significantly different at 0.05 level. ($P<0.05$)

For Experiment batch OPA grade
True-to-type percentage = 92.14%
Total Average Weight = 51.3 kg
Total Weight of true-to-type = 47.27 kg

For Control batch OPA grade
True-to-type percentage = 98.43%
Total Average Weight = 34.7 kg
Total Weight of true-to-type = 34.16 kg

For Experiment batch OP grade
True-to-type percentage = 75.52%
Total Average Weight = 50.8 kg
Total Weight of true-to-type = 38.36 kg

For Control batch OP grade
True-to-type percentage = 75.36%
Total Average Weight = 49.6 kg
Total Weight of true-to-type = 37.38 kg

For Experiment batch Pekoe grade
True-to-type percentage = 95.93%
Total Average Weight = 51.5 kg
Total Weight of true-to-type = 49.40 kg

For Control batch Pekoe grade
True-to-type percentage = 89.34%
Total Average Weight = 40.2 kg
Total Weight of true-to-type = 35.91 kg

For Experiment batch OP1 grade
True-to-type percentage = 86.92%
Total Average Weight = 34.7 kg
Total Weight of true-to-type = 30.16 kg

For Control batch OP1 grade
True-to-type percentage = 86.70%
Total Average Weight = 30.1 kg
Total Weight of true-to-type = 26.10 kg

CONCLUSIONS

Experiment batch shows proper particle size distribution rather than the Control batch. Experiment batch shows higher quantity of true to type grades with lesser quantity of over size and under size particles. The roll breaker which used for the experiment batch gives more quantity of proper even tea grades than the control batch for same quantity of green leaf. Therefore when comparing the both batches, experiment batch which used the mesh No. 3 and 4 combination roll breaker is the better one for the black tea manufacturing process than the control batch, which used the mesh No. 4 roll breaker for low country.

AKNOWLEDGEMENT

The author wish to thank, the staff of Technology Division, Tea Research Institute, Low Country Station, Rathnapura and St. Joachim factory, Rathnapura for their encouragement and assistance.

REFERENCES

Anon (2005). “Tea-export-countries.” Online. Available at http://www.pureceylontea.com (Retrieved march 20, 2006).

Anon (2004). Annual report, Central Bank of Sri Lanka, Colombo. pp 42-45

Anon (2003). Annual report 2001, Colombo, Sri Lanka Tea Board.

De Silva, W.C.A. (1972). Tea quarter, tea Research Institute of Sri Lanka

Jayatunga, N.G.P. (1999). Engineering Aspects of Tea Processing. National Institute of Plantation Management, M.D.H. Jayawardana Mawatha, Athurugiriya.

Mohamed, M.T.Z., G.L.C. Galahitiyawa, M.A. Chamindra and W.C.A. De Silva (2004). Classification of tea grades including long leaf types by sieve analysis, Sri Lanka Journal of Tea Science published by The Tea Research Institute of Sri Lanka.

Samaraweera, D.S.A. (1986). "Technology of tea processing." In Hand Book on Tea. The Tea Research Institute of Sri Lanka pp 192-193.