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Electronic vision study of tea grains color during Infusion

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ABSTRACT : *Tea manufacturing process basically observing with human eye vision. Electronic vision is very helpful to observe all process in tea manufacturing. Infusion is a very crucial process for good quality of black tea. Some change occurs during infusion , like odor changes in some fruity odor and green color convert into a dark brown color due to some complex chain reaction of biochemical enzymes subsequently inside the macerated tea leaf. Infusion depends on clone type, ambient temperature, relative humidity, airflow, duration time, leaf quality, color content and particle size of tea leaf, etc. Granule size of tea leaf is one of the important factors to achieve optimum time of infusion. Large granule size takes more time in oxidation in comparison to the small granule size. RGB (Red Green Blue) color model is a combination of red, green, and blue colors. . The variance of these components over the infusion period was analyzed. It was found that the intensity of Red color is increased, Green color is decreased and Blue color is increased as the infusion proceeded. It may also be noted that, in general, bigger size grain requires more time for the color changes than smaller size grain pointing to the fact that the rate of infusion may be low in bigger size grain. Detail studies; however, is required to specify the exact end point of infusion .*

Keywords : *Color, RGB color model, Granule size, Black tea, Fermentation.*

I. INTRODUCTION

Black tea is most widely routine drink in the world. Tea is basically produced by *Camellia sinensis* plant. All kinds of tea are made from this plant by changing tea manufacturing process. Macerated leaves with size reduction of 2 to 4 mm by CTC (crush tear and curl) machine allow for the infusion process. In this stage some enzymatic reaction takes place, causing some changes in tea leaves like greenish color to copper brownish color and some grassy smell convert to floral smell. Under infusion and over infusion may cause to divergence of quality tea. This process has to be stop at the optimum point for making good quality tea **[1]** .

Color is a very important factor in tea industries. For assessment of tea quality we prefer the color test of the process. There are some steps of processing of tea manufacturing which may be depends on the color test.

1.1. Plucking

In plucking, two leaves and a bud are a good for tea quality. These are basically new grown leaves with light green color and dark green colors are old leaves which not to be plucked for tea manufacturing. Other then this color may cause damage of the leaf.

1.2. Withering

In withering process the humidity content is reduce from 85% to 70-60% in around10 to 16 hours depending upon the type of manufacturing and atmospheric condition. Due to loss of humidity content and some biochemical changes in withering leaves, color changes from light green color to dark green color. Withered leaves colored to dark brown which is not allowed for tea manufacturing.

1.3. Infusion

During infusion , color changes to coppery brown. When leaves are in greenish color then it means the infusion process is in under infusion and when it turns very dark brownish color then it means that the process is over fermented. Infusion process should stop at copper brownish color as per the tea expert desire. This process has to stop on a particular color to maintain the good quality of tea and allow it for drying.

II. MATERIALS AND METHODS

I. Color models

The RGB color model (combination of red, green, and blue color) was used in the present study. It is based on the Young–Helmholtz theory of tri-chromatic color vision, developed by Thomas Young and Hermann Helmholtz, in the early to mid nineteenth century, and on James Clerk Maxwell's color triangle that elaborated that theory **[2]**. This model is able to produce any color. These color components vary from zero to 255 values. If all the components are at zero the response is black; if all are at maximum, the response is white, and if all values are equal then it produces gray color.

The color components may be measured in following ways:

a) In computing, the component values are often stored as integer numbers in the range 0 to 255, the range that a single 8-bit byte can offer (by encoding 256 distinct values).
b) Each color component value can also be written as a percentage, from 0% to 100%.
c) From 0 to 1, with any fractional value in between. This representation is used in theoretical analyses, and in systems that use floating-point representations.

Other color models are:

a) CMYK (Cyan Magenta Yellow Key (Black)) Color model **[5]**
b) L*a*b* Color model **[6]**
c) Grayscale model **[7]**
d) Bitmap model **[8]**
e) Duotone model **[9]**
f) Indexed Color model **[10]**
g) Multichannel model **Error! Reference source not found.**

The RGB color model **[11]** is used in the present study.

1.4. Image acquisition

In the experimental setup **Figure 1** we took a stand which the base was white background. A camera (2 mega pixel) was fixed between the stand and arrange it at that a place where the light source was constant.

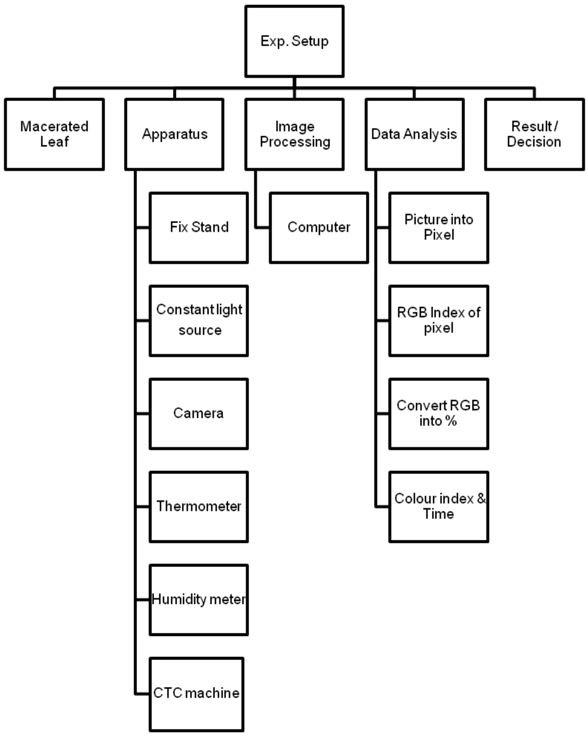


Figure 1. Experimental process

Samples of tea leaves were taken just after maceration and putting on the base of the stand with white background and start capturing the image with regular interval time of 5 minutes to 75 minutes. After capturing the image, the samples were dried and sieve analysis were made for the determination of particle size.

1.5. Image Color Analysis

We took images of specific area of the tea layer during the infusion process starting from 0 to 75 minutes. Adobe Photoshop CS3 software was used to convert the taken images into pixels of a specific area and calculate the average value of the RGB color index and converted them into %.

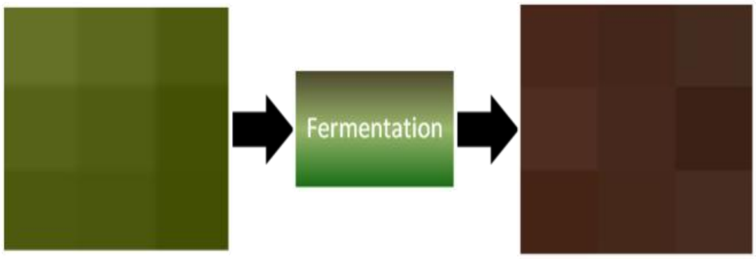


Figure 2. Color pixel conversion during infusion

1.6. Samples Preparation

Withered tea leaves feed into the laboratory scale maceration machine in the process of crushing, tearing and curling. This maceration machine was able to produce different sizes of tea grains Table 1. After a maceration of the tea leaves we spread them on white background stand for taking a higher quality image than images were taken soon after maceration and repeated at five minute intervals until 75 minutes because kharagpur region tea infusion varies from 55 to 70 minutes **Error! Reference source not found.**. So we took 10 min extra for better understanding of color properties of tea grains during infusion.

Table 1. Size of grains produced and used for analysis through image analysis **[2]**

S. No.	Grades	Grains Size(mm)	
1	Broken Orange Pekoe (Large)	BOPL	< 2.0
2	Broken Orange Pekoe	BOP	1.7 – 2.0
3	Broken Orange Pekoe (Small)	BOPSM	1.3 – 1.7
4	Broken Pekoe	BP	1.0 – 1.3
5	Pekoe Fanning	PF	0.5 – 1.0
6	Pekoe Orange	PO	0.33 – 0.5
7	Orange Fanning	OF	0.25 – 0.35
8	Dust	Dust	> 0.25

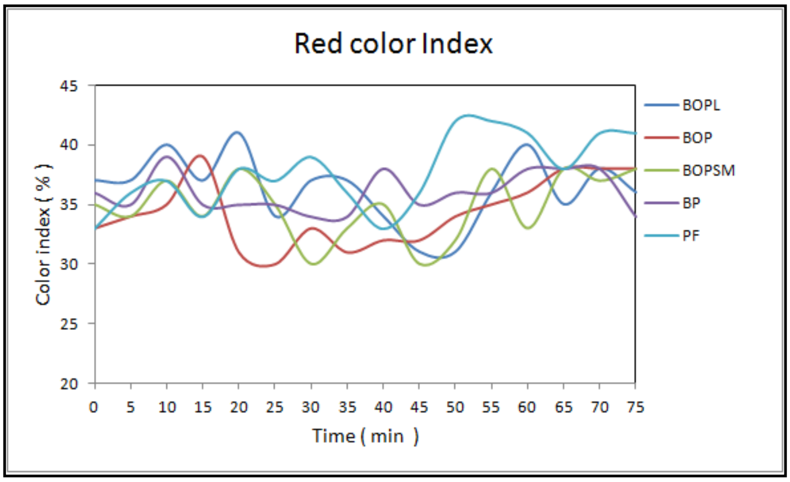
III. RESULT AND DISCUSSION

3.1. To Color study during infusion

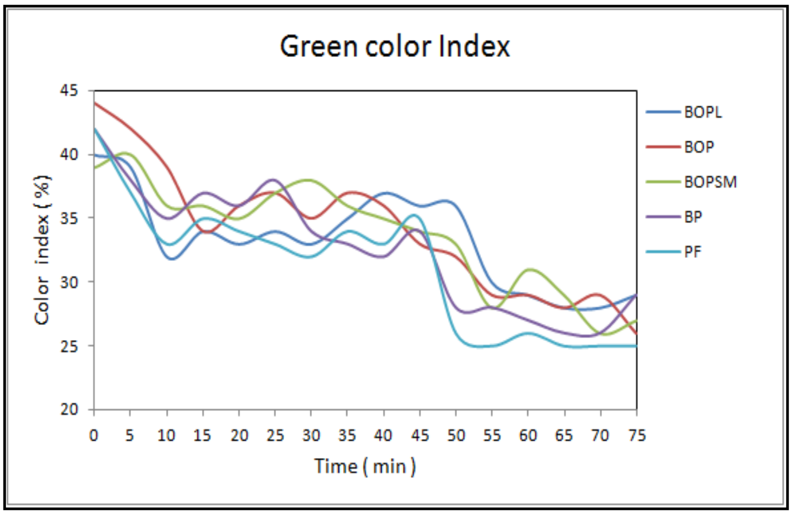
Some experiments were did in which we found a granule size dependency during infusion using RGB color model. With reference to color index we draw a graph with red, green and blue color index versus time. By **Figure 3 (a)** is observed that red color index path reaches little up with some damp between 20 min to 50 min of infusion . BOPL maintain its level after 75 min. BOP increases 33 to 38, and BOPSM increases 35 to 38. BP maintain its level with slight low value, but PF register a huge difference among all above tea grades due to its granule size. PF has a small granule size among all above grades and therefore surface area is more to take part in biochemical chain reaction during infusion . This means that it reacts more in comparison to the other grades, with more color difference as others grades. Here we found that as we decrease the granule size, the red color index start to creating adifference between the initial and final value.

The green color **Figure 3 (b)** index path goes down to maintain its level between 20 min to 45 min and decreases the color index value. BOPL decreases its level from 40 to 29 after 75 min. BOP decreases from 44 to 26, BOPSM decreases from 39 to 27, BP decreases from 42 to 29, but again PF registers a huge difference from 42 to 25 among the all above tea grades due to its granule size.

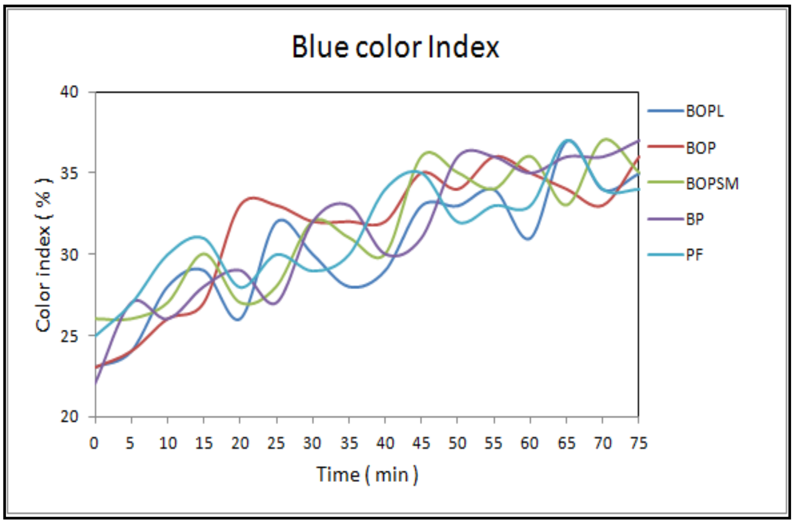
Figure 3 (c) shows that blue color index path goes linearly until 20 min and than starts a zig zag path until tha end. BOPL increases its level from 23 to 35 after 75 min. BOP decreases from 23 to 36, BOPSM decreases from 26 to 35, BP decreases from 22 to 37, and PF register approximate same level difference from 42 to 25 as all above tea grades due to its granule size.



(A)



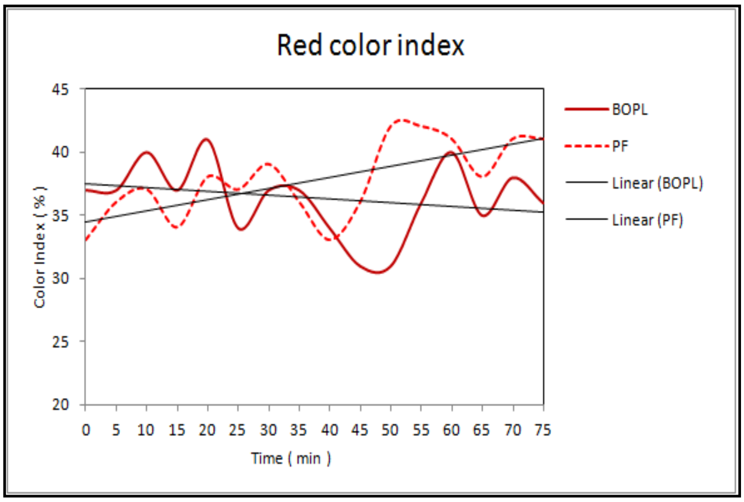
(B)



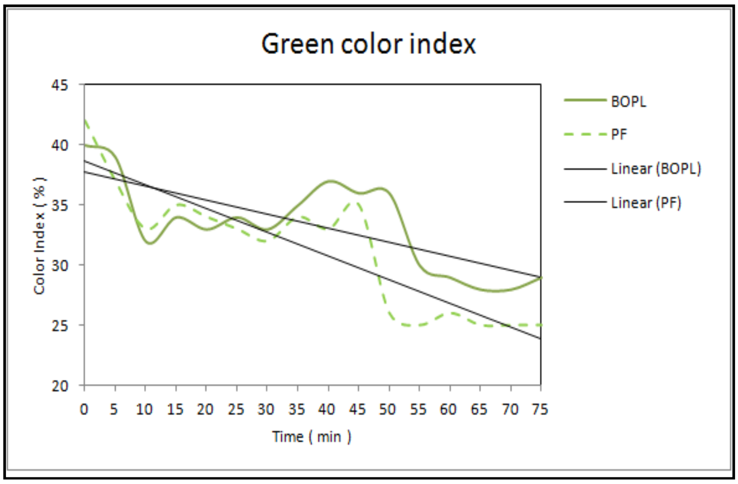
(c)

Figure 3. Graph between Red (a), Green (b) and Blue (c) color index along the infusion

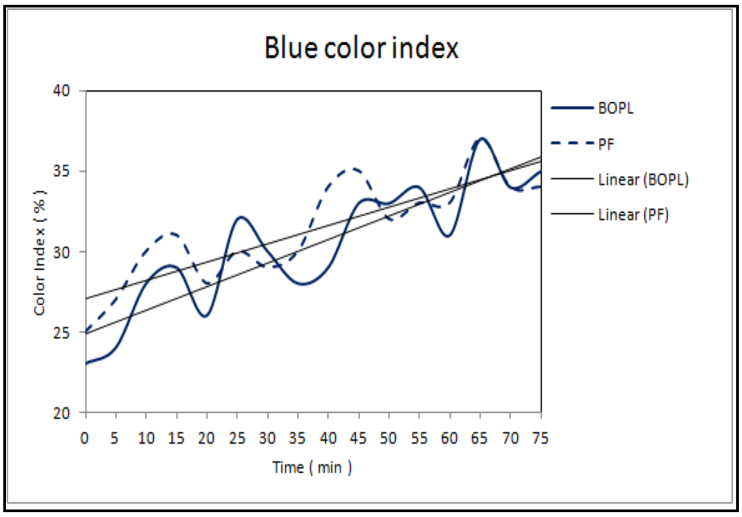
We can see by **Figure 4** that the biggest size (BOPL) has a different infusion end time color combination index then the smallest size (PF). It means that both have different infusion s time and that grain size plays an important role in the infusion process, causing different flavor and high-quality tea.



(A)



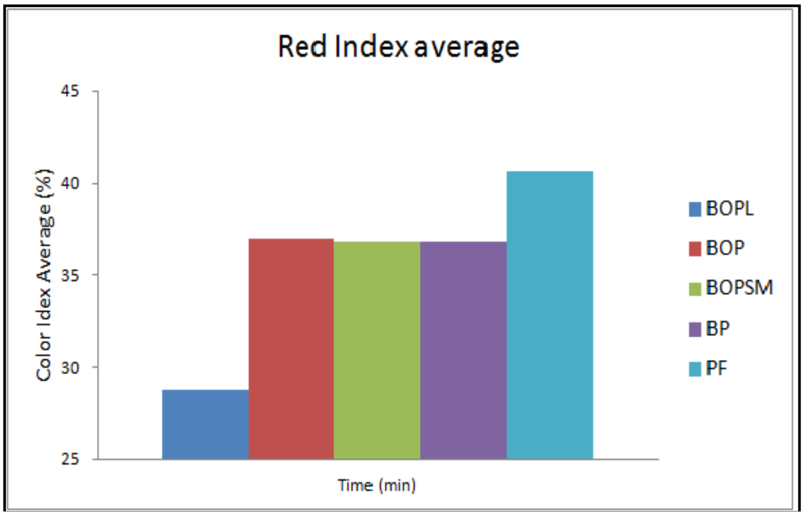
(B)



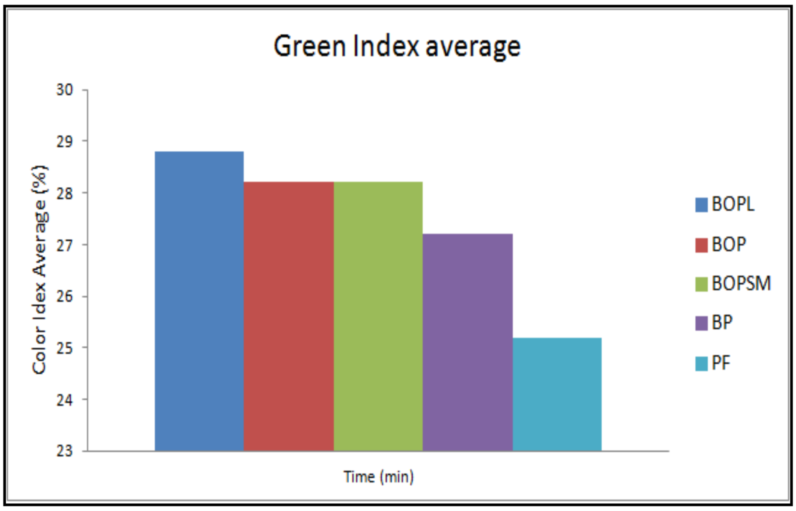
(c)

Figure 4. Graphs with initial and final value of large (BOPL) and small (PF) grade along the infusion

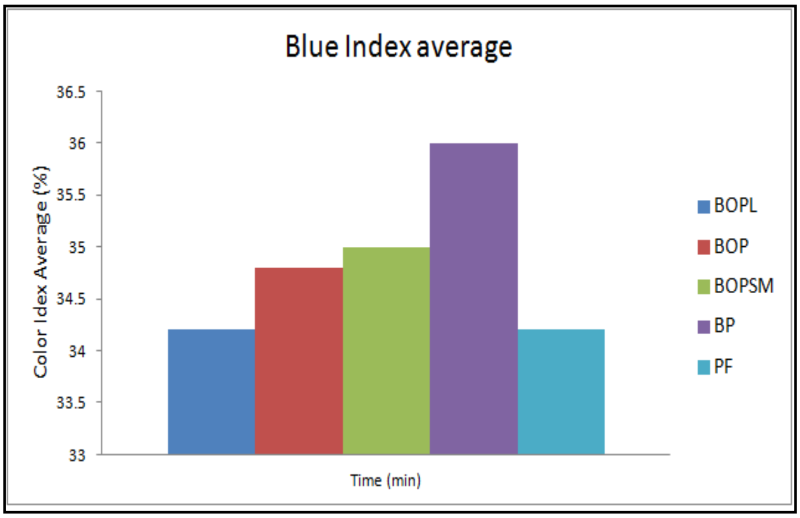
3.2. Granule size dependence on infusion



(A)



(B)



(C)

Figure 5. Average value of Red (a), Green (b) and Blue (c) color index from 55 to 75 min of infusion

With reference to **[13]** (CTC) black tea optimum infusion time varies from 55 min to 70 min. In this order, the granule size dependency on this infusion was studied with samples from 55 min to 75 min.. If there is no dependency on granule size then it should be approximately equal at one point after 55 min. But we found that red color index average of 55-75 min **Fig.5 (a)** was increasing with decreasing granule grade (BOPL 34, BOP 34.4, BOPSM 34.8, BP 35.24, PF 29.2). Green color index average **Figure 5 (b)** was decreasing with decreasing granule grade (BOPL 28, BOP 28.4, BOPSM 27.2, BP 26.8, PF 27.2) and green color index average **Figure 5 (c)** was decreasing with decreasing granule grade (BOPL 34.6, BOP 34, BOPSM 35.4, BP 34.8, PF 35.4). We can clearly see that the granule size of the tea leaf depends on infusion time We also study standard deviation (Fig.6) Thevariation was lower when starting until 15 min and after that variation increases until 60 min. After that, low variation was achieved which verify that Kharagpur region (CTC) black tea infusion lies between 55-70 min.

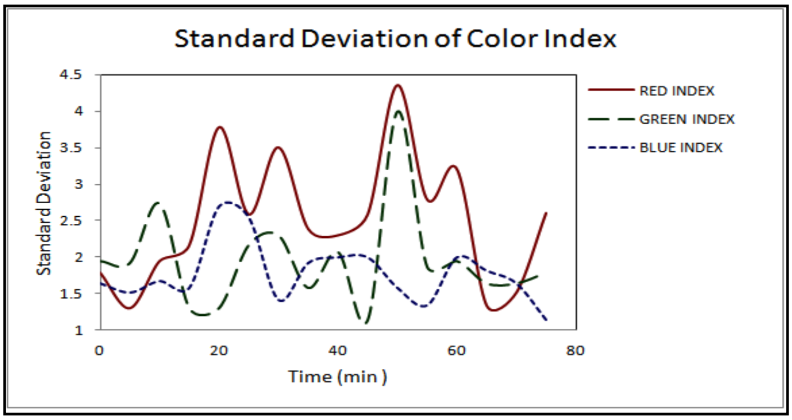


Figure 6. Standard deviation of color index

IV. SUMMARY

As in **[13]** we shown the importance of time during infusion process of tea. Where the granule size plays a vital role to vary infusion process time. So, In this experiment we found that different granule size during the infusion resulted in changing in RGB color component at a regular interval times. This study will be helpful to find out the optimum infusion time. Data can be generate with different environmental condition, relative humidity, temperature and train an electronic vision automated machine to observe and operate the infusion process electronically. With these results is possible to track the infusion process that will be able to achieve best quality of tea.

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