# Production and Analysis of Different Flavored Tea Pellets Made from Big Bulk in Tea Processing

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## Abstract

Tea pellets produced from refuse tea is a soluble solid of different flavoured tea. This research is to evaluate the quality of different flavoured tea pellets produced from refuse tea. The various processes involved in the production include oven drying, blending and sieving of refuse tea and black tea, flavour addition and moulding. A sample of refuse tea, black tea and flavour materials were oven dried, ground and sieved (sieve size 75µm) to obtain powdered form. The powdered ingredients were mixed in 7 different random ratios of treatments to form pellets which were pressed using mold and the dynamometer. Sensory analysis using a tasting panel and statistical analysis of sensory data showed that best ratios of refuse tea: black tea: flavor material for ginger and cardamom 7:2:2 and 7:3:1 respectively. The chemical analysis of TF: TR, TP, and MC within 0.08 to 0.1, min 9-11 and below 6.5% respectively. It is possible to develop value added products in the form of pellets using refuse tea and flavor materials to generate additional income from material which otherwise considered as a waste problem. It is suggested to study the economics of industrial production for a marketable product.

***Keywords:*** Product diversification, Refuse tea, Tea pellets, Tea standard, Value added tea

## 1. INTRODUCTION

The second most extensively consumed beverage in the world following water is tea (Mukhopadyay *etal*., 2012), and it has a slightly cooling, astringent flavor (Mondal *etal.,2004). Camellia sinensis* (L.) is an evergreen perennial shrub used for preparing the drink (Mukhopadyay *etal.*, 2013a, b). The tender leaves are processed to form a drink that offers people the crucial pep and input necessary for doing mental and physical work.

Tea [*Camellia sinensis* (L.)] is a Golden crop which exposes SriLankan territory to the international community. The immature shoots of tea are plucked at regular intervals and removed a certain number of various elements from the plant-soil system. It achieved finest reputation as "Ceylon tea" due to its high quality and inherent unique characteristics for more than hundred and fifty years. Sri Lanka exports more than 95% of tea production to about 140 countries in the world. As the fourth largest tea producer and third largest tea exporter, Ceylon tea contributes 307.08 million kilograms to the global tea production and exported 288.98 million kilograms in 2017.

It contributes 0.7 % of gross domestic production while generating 12.3% of net foreign exchange earnings for the nation (Anonymous, 2017). Approximately 205,000ha of tea lands are in 14 administrative districts in Sri Lanka.

Tea growing areas could be broadly categorized based on the elevation as low country (0-600m), mid country (600m-1200m) and up country (above 1200m).

The tea extent in the up, mid and low country are 18.5%, 32% and 49.5% of the total area under tea cultivation (Anon, 2012). Varying extent of tea lands found in around 25 out of the 46 Argo ecological regions varying extent of tea lands (Anon, 2008).

In tea manufacturing during olden days, waste tea produced was about 6-8%. This was because the industry was able to get good quality succulent leaf (2 leaves and a bud) for processing because there was plenty of labor available at that time. With the current shortage of labor in the tea industry the quality of leaf has gone down increasing the refuse tea % to 10-12% and sometimes as high as 14-15%. Refuse tea consist of fibrous tissue that is yellowish to reddish brown color.

In tea manufacturing the largest amount of energy is utilized for withering and drying. Therefore, refuse tea at present account for 10-12% of this energy utilization which adds to the cost of production.

In view of the above identification of alternative uses of refuse tea will be helpful to minimize the refuse tea cost of production. It could be used as a medium for mushroom cultivation, as fertilizer etc. currently most researchers concentrate on the impact of refuse tea on made tea yield. Even though there are various alternative methods to dispose refuse tea from the industry during tea processing, this study was focused on adding value to refuse tea by preparation of different flavored quality tea pellets by mixing refuse tea with flavor compounds.

## 2. MATERIALS AND METHOD

This research was conducted in the laboratory of Department of Agricultural Engineering, Faculty of Agriculture, University of Peradeniya, Kandy. The ingredients such as powdered refuse tea, black tea and flavors such as cardamom and ginger from which, refuse tea was collected from tea industry while black tea and flavors were collected from local market in Kandy.

The volume of ingredients (in g) for one tea pellet in order to produce 5mm thickness of pellet is 1.1g. According to that, the seven random proportionate treatment ingredients shown in Table 1.

**Table 1: Treatments and proportions of ingredients for flavored tea pellets preparation**

| Treatments | Amounts of ingredients (g) | | |
|---|---|---|---|
| | Powdered refuse tea | Powdered black tea | Powdered flavors (Ginger & Cardamom) |
| **TC** | Control | (market | tea) |
| **T1** | 0.7 | 0.2 | 0.2 |
| **T2** | 0.7 | 0.3 | 0.1 |
| **T3** | 0.6 | 0.3 | 0.2 |
| **T4** | 0.6 | 0.4 | 0.1 |
| **T5** | 0.5 | 0.3 | 0.3 |
| **T6** | 0.5 | 0.4 | 0.2 |
| **T7** | 0.4 | 0.4 | 0.3 |

## 2.1 Sensory evaluation

Quality attributes selected for sensory evaluation were brightness of tea liquid, color, appearance, taste, smell and overall acceptability.

The technique of tea tasting used was in conformity with the standard procedure.
The infusion has made by adding one pellet mixed in boiling water, covered by a lid and kept for 5 min, after which the infusion was evaluated for sensory qualities. Market tea was taken as the control for comparison among the quality attributes.

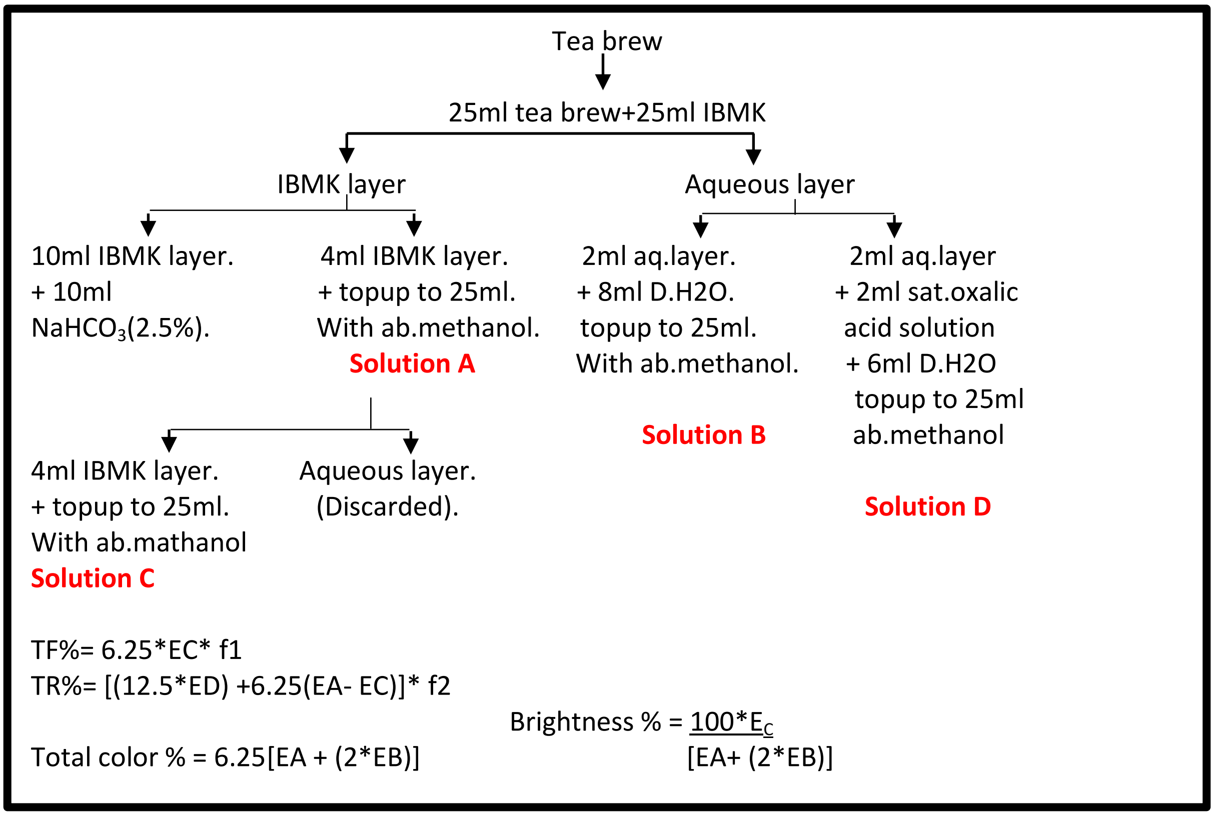
Panelists were supplied with evaluation sheets specially prepared for this purpose and asked to indicate their preference about sample quality by assigning a score (9-point hedonic scale). The score values obtained were averaged and evaluated statistically by using grouping test in Minitab software.

## 2.2 Determination of TF, TR, Color and brightness of tea samples

All chemicals were procured from Tea Research Institute, Talawakelle. The TF, TR, Color and brightness of tea samples were determined by the spectrophotometric method. The tea samples were analyzed in two replicates for various chemical constituents by standard procedure. Tea brew was prepared by mixing 9g of made tea in 375ml of boiling distilled water taken in an Erlenmeyer flask for 10 minutes, then filtered through a funnel containing cotton wool and the infusion was cooled to room temperature.

The reagents used were Iso Butyl Methyl Ketone (IBMK), NaHCO3, ab. methanol and saturated oxalic acid solution. A brief description of the methodology followed is presented in fig 1.

**Figure: 1 Method for determination of TF, TR, Color and Brightness**



The determination of color and % brightness of various samples and thereby find out the amount required to produce a cup of tea, which has the same % of brightness and color values as that of the tea available in the market.

Solutions A, B, C and D were prepared and the optical densities $E_A$, $E_B$, $E_C$, and $E_D$ of solutions A, B, C and D were measured at 380nm and 460nm in 1cm cells. The TF, TR, Color and brightness of tea samples were calculated from the relationships shown in fig 1.

$f_1$ and $f_2$ are the corresponding spectrophotometric conversion factors which are indicated in the equations shown in fig 1.

$$f_1 = \frac{0.02*856.7*375}{2.225*892.7*\text{sample weight}}$$

$$f_2 = \frac{0.02*375}{0.733*\text{sample weight}}$$

The TF and TR contents being calculated from measurement of optical density made at 380nm while total color and brightness made at 460nm.

**2.3 Determination of total polyphenols**

Estimation of total polyphenols was carried out with Folin ciocalteau reagent. For this determination, first dry matter content of each sample was determined by oven dry method. The chemicals that are required for this determination were procured from Tea Research Institute, Talawakelle.

The tea samples were analyzed in two replicates for the polyphenol extraction with 70% methanol from a test portion of about 0.2g of each flavored sample at $70^0$ c. Absorbance of the sample was measured at 765nm and amount of polyphenols determined by using Gallic acid as standard.

**2.4 Determination of dry matter content**

The dry matter content was estimated according to oven dry method (AACC, 2000) by drying each sample of about 2g (nearest 0.001g) placed into oven at 105± $5^0$ c till the weight of the sample became constant. The dry matter content was calculated as,

$$DM\ \% = \frac{\text{weight of dried sample (g)}}{\text{Weight of fresh sample (g)}} * 100$$

# 3. RESULTS AND DISCUSSION

## 3.1 Sensory evaluation

**Figure 2: Parameters vs. Treatments for ginger flavored tea**

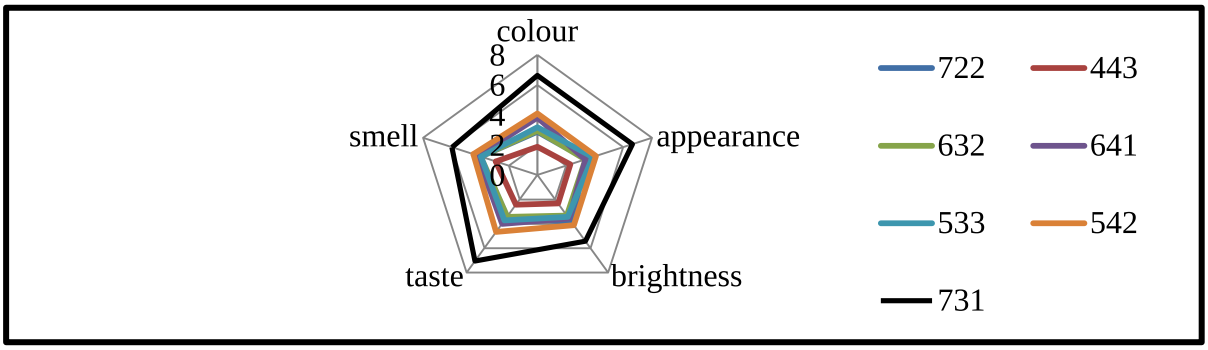



**Figure 3: Parameters vs. Treatments for cardamom flavored tea**

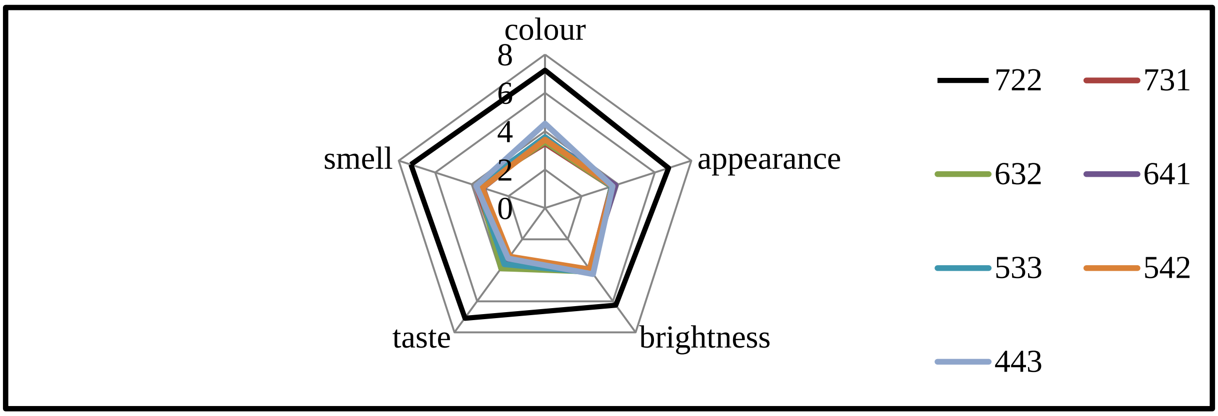



Figure 2 & 3 shows score values during sensory analysis of different treatments. The parameters with maximum score values are good in quality according to the preference of panelists.

The first preference of treatment was indicated by score value "9" followed by "8", "7" up to "1" which is the least preference. The outer polygon shown in Figure 2 & 3 depicts the best treatment proportions of sensory analysis conducted for each flavored tea pellet.

The outer polygon shown in black color (7:2:2 proportion) & (7:3:1 proportion) treatment is the best for ginger & cardamom flavored tea respectively.

**Table 2: Summarized results of sensory analysis**

| Type | Refuse tea | Black tea | Flavor | Best treatment |
|---|---|---|---|---|
| Ginger | 0.7 | 0.2 | 0.2 | 7:2:2 T1 |
| Cardamom | 0.7 | 0.3 | 0.1 | 7:3:1 T2 |

Table 2 shows the summarized results of sensory analysis. However, the above results shown in Table 2 from the sensory analysis, do not indicate the significance of the best treatment. Therefore, sensory data were analyzed statistically by using "Minitab" software and was performed to identify grouping showing the highest statistical significance.

**Table 3: Grouping output from the statistical analysis done for ginger flavored tea**

| | T1 | T2 | T3 | T4 | T5 | T6 | T7 |
|---|---|---|---|---|---|---|---|
| **Color** | $7.182^{a}$ | $3.364^{b}$ | $3.455^{b}$ | $3.636^{b}$ | $3.697^{b}$ | $3.576^{b}$ | $4.394^{b}$ |
| **Appearance** | $6.758^{a}$ | $3.636^{b}$ | $3.636^{b}$ | $3.848^{b}$ | $3.636^{b}$ | $3.697^{b}$ | $3.697^{b}$ |
| **Brightness** | $6.242^{a}$ | $3.970^{b}$ | $4.091^{b}$ | $3.939^{b}$ | $4.152^{b}$ | $3.939^{b}$ | $4.242^{b}$ |
| **Taste** | $7.091^{a}$ | $3.667^{b}$ | $3.879^{b}$ | $3.273^{b}$ | $3.606^{b}$ | $3.121^{b}$ | $3.242^{b}$ |
| **Smell** | $7.333^{a}$ | $3.758^{b}$ | $3.606^{b}$ | $3.394^{b}$ | $3.667^{b}$ | $3.424^{b}$ | $3.758^{b}$ |

**Table 4: Grouping output from the statistical analysis done for cardamom flavored tea**

| | T1 | T2 | T3 | T4 | T5 | T6 | T7 |
|---|---|---|---|---|---|---|---|
| **Color** | $2.879^{cd}$ | $6.636^{a}$ | $2.939^{c}$ | $3.818^{bc}$ | $3.182^{bc}$ | $4.091^{b}$ | $1.879^{d}$ |
| **Appearance** | $3.394^{bc}$ | $6.636^{a}$ | $3.364^{bc}$ | $3.364^{bc}$ | $3.879^{b}$ | $4.091^{b}$ | $2.303^{c}$ |
| **Brightness** | $3.848^{b}$ | $5.424^{a}$ | $3.333^{bc}$ | $3.576^{b}$ | $3.424^{bc}$ | $4.121^{b}$ | $2.333^{c}$ |
| **Taste** | $3.424^{cd}$ | $7.061^{a}$ | $3.424^{cd}$ | $4.000^{bc}$ | $3.727^{bc}$ | $4.667^{b}$ | $2.424^{d}$ |
| **Smell** | $3.970^{bc}$ | $5.970^{a}$ | $3.970^{bc}$ | $4.182^{bc}$ | $3.939^{bc}$ | $4.415^{b}$ | $2.909^{c}$ |

Table 3 & 4 shows T1 (Treatment 1) & T2 (Treatment 2) appears to be the best proportion with statistical significance for ginger & cardamom flavored tea respectively as the outcome of sensory analysis.

### 3.2 Determination of TF, TR, Color and Brightness of samples

TF has a direct correlation with quality and therefore price of the product. TF has a relation towards the briskness and brightness of tea liquor. During the course of fermentation, TF progressively increases till an optimum fermentation time, the period at which maximum quality is observed. In addition to having maximum value for TF, there has to be proper balancing of the liquor parameters for which the guideline stating the value of TR to be 10-12 times as that of TF can be allowed. TR is complex condensation products of oxidized catechins with TF. TR increases the color, mouth feel and body of the tea liquor together with High Polymerized Substances. Very high levels of TR indicate over fermentation. Similarly, very high levels of Total Liquor Color also imply over fermentation. Low levels of TR indicate under fermentation and also the liquor tastes harsh.

**Table 5: Absorbance values of duplicated different flavored tea samples in order to determine TF, TR, total color & brightness**

| Samples | rep | A | | B | | C | | D | |
|---|---|---|---|---|---|---|---|---|---|
| | | 380 nm | 460 nm | 380 nm | 460 nm | 380 nm | 460 nm | 380 nm | 460 nm |
| zero | | 0.109 | 0.109 | 0.109 | 0.108 | 0.109 | 0.109 | 0.132 | 0.124 |
| Ginger | 1 | 0.530 | 0.126 | 0.894 | 0.257 | 0.265 | 0.194 | 0.654 | 0.221 |
| | 2 | 0.587 | 0.169 | 0.895 | 0.244 | 0.276 | 0.226 | 0.698 | 0.217 |
| Cardamom | 3 | 0.583 | 0.149 | 0.685 | 0.347 | 0.338 | 0.125 | 0.702 | 0.236 |
| | 4 | 0.570 | 0.138 | 0.674 | 0.331 | 0.302 | 0.101 | 0.729 | 0.226 |

Table 5 shows the absorbance values got from spectrophotometry for duplicated different flavored tea samples in order to determine TF, TR, color and brightness of each samples. The enzyme polyphenol oxidase is responsible for oxidizing the catechins to Thea Flavin (TF) and Thea Rubigins (TR), the tea pigments responsible for the color and taste of black teas (Sharma, Gulati, & Ravindranath, 2005). The readings of 380 nm from Table 3 is for the determination of TF & TR. While, the readings from 460 nm is for the determination of color and brightness. A, B, C, and D are the solutions which were prepared in order to measure the values shown in the Table 5. From these solutions, solution A is used for the determination of TR%, color and brightness. Solution B, used for determining color and brightness. Solution C, used for TF%, TR% and brightness determination. While the solution D, used for the determination of TR% during chemical analysis.

**Table 6: Average TF%, TR%, Color and brightness of made tea samples**

| Sample | Sample wt | Rep | TF | | TR | | TF: TR | Color | | Brightness | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | % | avg | % | avg | | % | avg | % | avg |
| Ginger | 9.07g | 1 | 0.59 | 0.61 | 7.35 | 7.5 | 0.081 | 4.00 | 4.05 | 30.32 | 32.41 |
| | | 2 | 0.62 | | 7.65 | | | 4.10 | | 34.49 | |
| Cardamom | 9.12g | 3 | 0.75 | 0.71 | 7.25 | 7.8 | 0.091 | 5.26 | 5.13 | 14.81 | 13.75 |
| | | 4 | 0.67 | | 8.35 | | | 5.00 | | 12.68 | |

The Table 6 shows the average values for TF%, TR%, color and brightness for made tea sample. The TF: TR ratio for soluble tea was 0.084. This ratio should be within 0.08 to 0.1 for a good quality tea (Wherkoven, 1974). TF: TR ratio of prepared tea samples are between the values ranges shown in Table 6.

The presence of Thea Flavin and Thea Rubigins in green tea indicates breach of production technology and storage conditions (these components should not be present in true green tea). For assessment of black tea quality, we suggest consideration of the proportion of Thea Flavin concentration to the Thea Rubigins concentration. High-quality black tea must contain over 1% of Thea Flavin and approximately 10% of Thea Rubigins, and their ratio must be greater than 0.1. Tea tasters ensure the high quality of black tea only at such ratio of Thea Flavin to Thea Rubigins.

Low TF content in black tea may be because of over fermentation and/or long periods of storage (Yao *etal*., 2006). Similar observations were made by Masoud *etal*., (2006) on different manufactured orthodox and CTC teas.

The amount of Thea Flavin and Thea Rubigins were influenced by the temperature, extraction time and optimum level of briskness and color indices will have a fermentation stage. Teas having maximum TF and a balanced TF/TR ratio (O.08-0.1) with better quality. As shown in Table 6, while color % increases, brightness decreases after a certain limit. The average color, brightness % with the acceptable ranged TF: TR% is the best quality tea.

### 3.3 Determination of dry matter content

The problem of setting quality standards to made tea arises due to multitude of factors affecting the quality starting from the raw material to the variations in manufacturing conditions. Moisture content is one of the important parameters for tea quality (Roberts and Smith, 1963).

The results of the studies for tea (Othieno & Owuor, 1984; Robinson & Owuor, 1993) have shown that the moisture content of tea should be controlled and be present under 6.5% for black teas, although Millin, (1987) believed that tea had a moisture level of 7–8% during retailing.

Table 7 shows the average dry matter content in each flavored tea samples prepared. According to the results obtained, the highest moisture content is 5%.
Therefore, the moisture level is in acceptable range in each sample for long shelf life.

**Table 7: Average dry matter content in each sample**

| Sample | replicate | W1 (empty dish weight) (g) | W2 (sample weight before drying) (g) | W3 (sample weight after drying) (g) | DM% |
|---|---|---|---|---|---|
| Ginger | 1 | 8.903 | 10.993 | 10.889 | 95 |
| | 2 | | 11.033 | 10.927 | |
| Cardamom | 3 | 9.203 | 11.243 | 11.202 | 98 |
| | 4 | | 11.313 | 11.271 | |

### 3.4 Determination of Total polyphenols

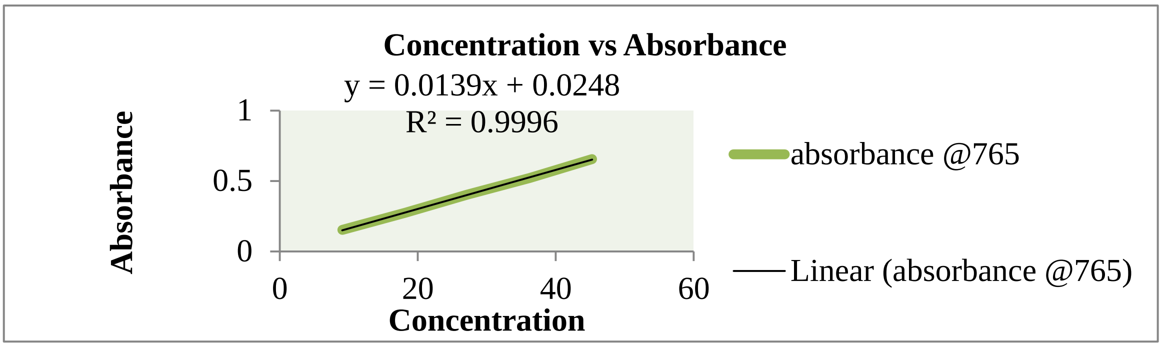
Table 8 and the corresponding graph in Figure 4 shows the absorbance values at 765 nm for different concentrated stock solutions of Gallic acid in order to determine total polyphenols in each prepared sample. The Figure 4 shown is the standard curve used for the calculation of total polyphenols with the help of different absorbance values for duplicated each flavored sample. According to the standard curve shown, from the equation derived from the curve, X value was calculated and from that TPP% was resulted as shown below using

$$TPP\% = \frac{X*10*100}{\text{Actual weight}} *10^{6}$$

**Table 8: Absorbance values at 765 nm for different concentrated stock solutions of Gallic acid**

| Gallic acid µg/ml | Actual con (ppm) | Absorbance at 765nm |
|---|---|---|
| 10 | 9.056 | 0.1523 |
| 20 | 18.112 | 0.2741 |
| 30 | 27.168 | 0.4022 |
| 40 | 36.224 | 0.5209 |
| 50 | 45.28 | 0.6562 |

**Figure 4: Standard curve used for the calculation of total polyphenol**




The polyphenols in extract were determined colorimetrically using Folin – Ciocalteu phenol reagent. The reagent contains phosphotungstic acids as oxidants, which on reduction by readily oxidized phenolic hydroxyl groups yield a blue color with a broad maximum absorption at 765nm. This is due to the formation of so-called tungsten and molybdenum blues.

The Folin-Ciocalteu phenol reagent reacts with a wide range of polyphenol compounds and, although the response can vary with the individual components, selection of Gallic acid as a calibration standard enables useful total Polyphenol data to be obtained. Total polyphenols should be within min 9 to 11 % for a good quality tea.

The total content of polyphenols can be an indicator of tea quality. Table 9 shows total polyphenol% between 9 and 11 according to the standard value. So, it is in acceptable range in each flavored tea samples.

**Table 9: Calculation of total polyphenols in tea sample**

| **Sample** | **rep** | **weight (g)** | **absorbance** | **DM%** | **actual weight** | **X** | TPP% Total | Avg |
|---|---|---|---|---|---|---|---|---|
| **Ginger** | 1 | 0.209 | 0.300 | 95 | 0.199 | 19.798 | 9.971 | 9.9 |
| | 2 | 0.213 | 0.301 | 95 | 0.202 | 19.874 | 9.821 | |
| **Cardamom** | 3 | 0.204 | 0.289 | 98 | 0.200 | 19.036 | 9.521 | 9.41 |
| | 4 | 0.211 | 0.292 | 98 | 0.207 | 19.208 | 9.289 | |

## CONCLUSION

This study shows the possibility of producing different flavored tea pellets using refuse tea as the medium. The liquor produced by the tea pellets is of good color, pungency and other liquoring characteristics.TF, TR and polyphenol contents are also in the acceptable range.

The tea pellets produced is Soluble in hot water with minimal suspended particles. The tea pellets made from refuse tea which is comparable to market tea in quality and liquoring characteristics.

Thus, a value added product can be developed as pellets using refuse tea as a medium with different proportions of flavoring material and black tea with satisfactory consumer appeal.

## SUGGESTIONS

It is necessary to evaluate the economic feasibility of the technology involved in preparation of tea pellets and also should identify suitable packaging for extended shelf life.

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