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Wet Analysis of Qualified Shoots of Green Tea

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ABSTRACT

Tea (*Camellia sinensis* L.) is a plant native to Asia, especially China. However, it has now spread throughout the world, including across various regions of Indonesia where many different tea products are available. Tea is one of the most widely consumed beverages globally, second only to water, and is often regarded as a health-promoting drink. Product quality control is essential for maintaining and improving the product's quality according to established standards. In green tea processing, quality control generally begins with the reception of fresh tea leaves and is conducted through wet shoot analysis. This analysis plays a crucial role in the tea industry, particularly in determining the final product's quality. Its primary objective is to ensure that the tea shoots meet company standards, typically involving a visual inspection to verify that the shoots are free from pests, diseases, old leaves, and other foreign materials. The analysis results indicated that most tea shoot samples met the MS (Qualified Shoots) standard. However, variability was observed, influenced by plucking techniques, environmental conditions, and fertilization practices. Observations were made through direct observation of each production process and the surrounding environment. Interviews were conducted through direct question and answer activities with the supervisor, foreman of each process, laboratory staff, and employees. This method is carried out spontaneously by discussing the questions asked during observation which will then be recorded. Sample collection was performed randomly from several waring packs and mixed evenly. From the mixture, 500 grams of samples were taken for analysis. The shoots were then separated into fine and coarse categories. Based on the data collected, it was concluded that the average percentage of shoots meeting the MS standard was only achieved on days 9 and 14. The average percentage of fine shoots per day was recorded as follows: 22%, 25%, 22%, 23%, 19%, 20%, 19%, 24%, 28%, 20%, 24%, 27%, 24%, 29%, and 19%. Several factors affecting the quality of tea shoot harvests at the industry include inaccurate plucking methods, rotation intervals, suboptimal plant maintenance, and high rainfall. In addition, insufficient fertilization can slow shoot growth, resulting in failure to meet the required standards.

Keywords: Fine Tea Shoot, Green Tea, Wet Analysis,

Introduction

Tea (*Camellia sinensis* L.) is a plant native to Asia, especially China, but now tea has spread throughout the world even in all corners of Indonesia various tea products can be found. Tea is one of the drinks that is widely liked and consumed by people around the world after water, even most people utilize tea as a healthy drink. Tea can be drunk hot or cold as a refreshing drink, and many even mix certain ingredients in tea to improve taste (Bayani & Mujaddid, 2015).

Green tea is considered healthier because it is rich in antioxidants, especially catechins and polyphenols, which play an important role in fighting free radicals that cause cell damage and premature aging. These active substances have also been shown to lower cholesterol levels, maintain heart health, and reduce the risk of

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chronic diseases such as stroke, diabetes, and some cancers. Green tea has an important role in the metabolism of tissues such as adipose tissue, muscle, and liver (Rocha et al. 2016).

The important components of green tea are polyphenols, the most important of which are flavonoids. The main flavonoids in tea are catechins, forming 30-40% of the water-soluble solids in green tea. The highest concentrations of green tea phenolic compounds are gallic acid (GA), gallocatechin (GC), catechin (C), epicatechin (EC), epigallocatechin (EGC), epicatechin gallate (ECG), epigallocatechin gallate (EGCG), p-coumaroylquinic acid (CA), and gallocatechin-3-gallate (GCG) with EGCG being the most abundant by weight. Green tea also contains condensed and hydrolyzed tannins.

Product quality control is carried out to maintain and improve product quality in accordance with established standards. In general, quality control of green tea processing quality is carried out at the initial stage of receiving fresh tea leaves through wet analysis of tea shoots. This analysis aims to ensure that the shoots used meet industry standards, which usually involves visual inspection to ensure the shoots are free from pests, diseases, old leaves, and other foreign materials, estimation of the percentage of grade I yield, and is used to evaluate the quality of the raw tea shoot material. (Jasmine & Rahmadhia, 2024).

Quality control is carried out by analyzing the quality of shoots, namely wet analysis upon arrival of raw materials or wet shoots in accordance with industry Standard Operating Procedures (SOP). The quality of raw materials (wet shoots) greatly affects the quality of tea, the better the wet shoots, the tea produced will have good quality (Deka, et al., 2024).

The role of wet analysis is crucial as the quality of wet tea shoots directly affects the moisture content, density and chemical composition of dried tea, which ultimately determines the quality and selling value of the final product. In addition, this analysis also serves as an early detection tool to identify potential problems, such as inappropriate picking techniques or sub-optimal post-harvest handling, so that corrective actions can be taken earlier to maintain quality consistency. The implementation of strict quality control of tea shoots through wet analysis not only improves the efficiency of the production process, but also has a positive impact on consumer satisfaction, because the final product produced will comply with the predetermined moisture content and quality standards (Putri, et al., 2021).

Research Method

The materials used in this study include green tea shoots from each *Afdeling*, where each sample has been weighed to determine the overall quantity obtained from each *Afdeling*. Sampling was done randomly from several waring packs to ensure even representation of the harvest. To accommodate the collected green tea, baskets were used as the main container during the collection and transportation process. In addition, digital scales were used to ensure weighing accuracy, especially in the process of separating the selected fine shoots. The fine shoots that met the criteria were then placed in plastic as the final container before further analysis.

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The data collection method was carried out through wet analysis which was carried out every morning, coinciding with the arrival time of tea raw materials before entering the withering stage. There were four *Afdeling* blocks observed, so that every morning four wet analysis data were collected. Sampling was done randomly from several waring packs, then all samples were mixed evenly to get a homogeneous representation. From the mixture, a 500 gram sample was taken for analysis. The sample was then separated into fine shoots and coarse shoots. The identification of fine shoots was done by manual method, i.e. by breaking the tea shoots using one hand; if a 'click' sound was heard, then the shoots were categorized as fine shoots. After separation, the fine shoots were weighed and then the percentage of the total sample was calculated using the formula:

$$\text{Wet analysis} = \frac{\text{weight of fine shoots (g)}}{500\text{g}} \times 100\%$$

SPC or Statistical Process Control is a method used to monitor, control, and improve the quality of production processes or services using statistical tools, also known as the seven tools. The seven tools are a set of basic statistical tools used to identify, analyze, and improve quality issues in a production process or system. The seven tools are check sheets, histograms, Pareto charts, cause-and-effect diagrams, scatter diagrams, control charts, and flow charts. To monitor the stability and consistency of tea leaf quality in this industry, statistical tools such as control charts are used. Control charts indicate whether a process is still within statistical control limits (stable) or experiencing deviations that need to be addressed. This chart displays process data (e.g., average, number of defects, or variation), along with the upper control limit (UCL) and lower control limit (LCL). Control charts are used to identify whether the tea picking process is under control or if there are areas that need to be re-evaluated. UCL and LCL can be calculated using the following formula:

$$UCL = \bar{x} + 3STDEV \qquad LCL = \bar{x} - 3STDEV$$

Results and Discussion

Quality control is carried out on raw materials (wet shoots) during shoot acceptance (Haryadi & Iftinaan, 2022). Quality control on wet shoots is called shoot analysis. Shoot analysis is the separation/grouping of shoots based on the criteria of "Qualified" (MS), namely young shoots and "Non-Qualified" (NMS), namely old shoots and damaged shoots. The results of shoot analysis are expressed in percent and are the basis for estimating the quality of processed tea. According to Jasmine & Rahmadhia (2024), industry standards stipulate that the percentage of MS in green tea shoots is in the range of 30 - 40%. However, the industry standard for MS of green shoots is 28%. The setting of this standard is most likely based on considerations of quality, efficiency, and sustainability of high-quality tea production. Qualified shoots are young shoots that are not affected by pests, do not contain old leaves, and are free from contamination from other plants. Shoot analysis is a parameter that

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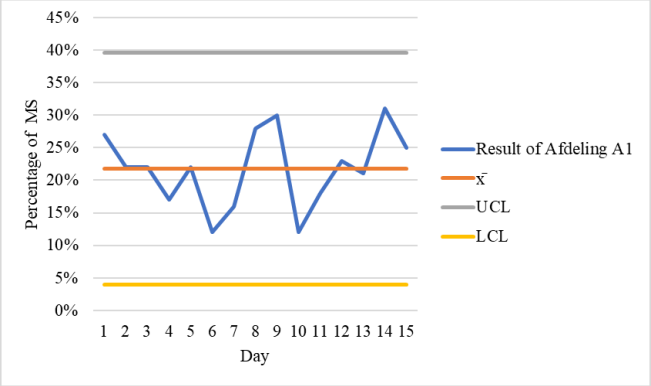
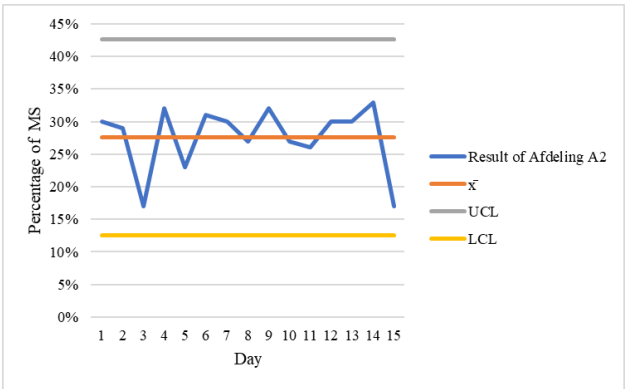
can be used to evaluate the picking system, picking rotation, and the performance of picking and transport organizations. Good quality tea shoots can result from the harmony in a series of plucking management to harvesting and transportation facilities.

Based on 15 days of wet analysis data collection, the average yield of fine shoots is only 23%. This can be interpreted that in these 15 days, the yield of fine shoots in the industry has not met the minimum requirements for the potential yield of Grade I tea. The average daily fine shoot income that meets the standard is day 9 and day 14, which is 29%. The highest analytical results were found in the plucking under the supervision of the foreman of *Afdeling* A2. While the lowest results were for picking under the supervision of the foreman of *Afdeling* B1. The difference between the results of the two *Afdeling* is quite far at 7%.



In the control chart of *Afdeling* A1 above, all data points from daily observations are located between this UCL and LCL, indicating that the tea bud picking process in *Afdeling* A1 is running in a stable and controlled condition. The fluctuations in MS values that occur from day to day are normal, without any patterns that show consistent or extreme increases or decreases. However, the average MS of 22% is still relatively low when compared to the optimal standards generally expected in the production of high-quality tea. Therefore, although the data collection process shows stability, quality improvement efforts are still needed so that the MS value approaches or reaches the desired target.



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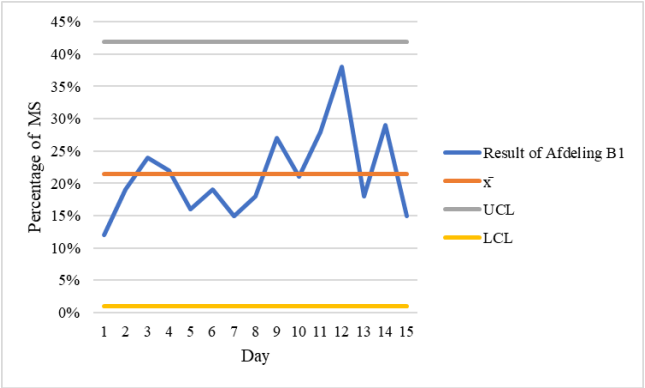
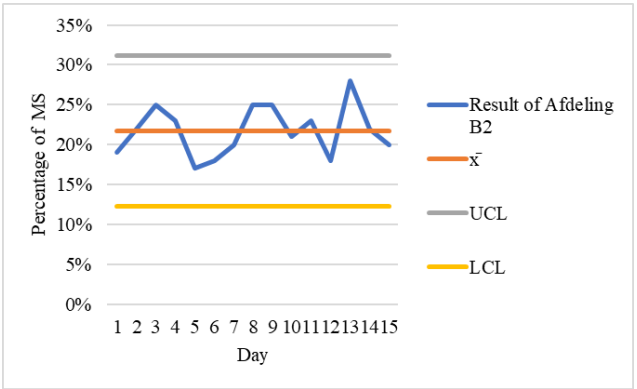
In the control chart of *Afdeling* A2, it can be seen that the results of the percentage of wet shoot analysis from day 1 to day 15 show variations that are generally within the statistical control limits. Almost all data points are between the UCL and LCL, except on days 3 & 15, where the MS value decreases to the extreme until it approaches the lower limit of the lower control. This indicates that there is process instability on day 3 & 15 that needs to be evaluated. In general, the data fluctuations from day 1 to day 14 are quite stable and do not show any suspicious up or down patterns, so the process in that period can be categorized in a controlled condition. However, days 3 & 15 are early indications that there are special factors or changes in the process that cause these deviations. Therefore, it is necessary to evaluate operational factors, such as weather conditions, picker skills, or raw material quality on those days , to maintain the stability of MS quality in *Afdeling* A2.



In the control chart of *Afdeling* B1, it can be seen that the MS percentage value from day 1 to day 15 shows quite dynamic variations. Most of the data points are within the UCL and LCL ranges, indicating that in general the process is still under control. However, there are quite extreme fluctuations, especially on day 12, where the MS value peaks near the upper limit of control, before dropping dramatically on the following days. This pattern indicates that there are special variations or extraordinary factors that affect the picking quality on certain days. However, no data points were found that went outside the control limits, so the process can be said to be still in statistical control. To maintain quality stability in *Afdeling* B1, more intensive monitoring of production factors is needed, especially on days with a marked increase or decrease in MS.



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In the control chart of *Afdeling* B2, it can be seen that the MS percentage value from day 1 to day 15 shows a relatively stable variation. All daily data points are between the UCL and LCL, indicating that the tea shoot picking process in *Afdeling* B2 is in a statistically controlled condition. Fluctuations in MS values from day to day are not too extreme, with reasonable variations and do not show a consistent upward or downward trend pattern. There is no indication of any deviation that requires immediate corrective action. Overall, the process stability in *Afdeling* B2 is quite good, although the average MS value can still be further optimized to approach or exceed the upper control limit to improve the quality of the harvest.

Based on the analysis of the control charts for *Afdeling* A1, A2, B1, and B2, it can be generally concluded that all *Afdeling* shows that the tea shoot picking process is still under statistical control. This is characterized by all data points being within the UCL and LCL of each affdeling, with no consistent extreme deviations. *Afdeling*. Although stable, the average MS value in the four *Afdeling*s still needs to be improved to approach the optimal quality standard of tea buds, as some *Afdeling*s have a relatively low average MS. Therefore, quality improvement efforts need to be made through labor training, stricter supervision of picking techniques, as well as evaluation of environmental and operational factors.

The difference in fine shoot income between *Afdeling* can occur due to several factors, namely environmental factors, quality and consistency of labor, and the influence of plant maintenance. Each block between *Afdeling* has different soil conditions, altitude, and humidity which may affect differences in the growth of tea shoots. The quality of pluckers' skills can also affect the plucking results to be uniform and of high quality, besides that if the pluckers lack enthusiasm or fatigue, they can produce tea shoots that are not in accordance with the standard. Lack of equal fertilization can make the quality of tea shoots different between *Afdeling* and block.

Tea plants that experience growth disorders, such as improper pruning, suboptimal fertilization, or pest attacks, have the potential to reduce the amount of fine shoots produced. Tea plant maintenance must be done to improve the quality of tea shoots. Proper pruning is essential to stimulate new shoot growth and keep the picking field low and wide. Pruning should be done with sharp tools and the correct technique, such as making a pruning wound with an angle of about 45° (Anjarsari, 2021). Maintenance can be done by fertilizing and controlling pests and diseases. Fertilization can be with nitrogen (N) fertilizer which can help the growth of greener shoots and is rich in catechin content, phosphorus and potassium fertilizers can also increase plant resistance to pests and diseases. Lack of fertilizer can cause the shoots to grow slowly and may not even meet the standard. However, over-fertilization can lead to unbalanced growth and lower tea leaf quality (Pamungkas & Supijatno, 2017).

Pest and disease control is very important for tea plant growth because pest and disease attacks can interfere with plant health, reduce production, and reduce the quality of tea shoots which are the main part

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harvested. Disturbances from Plant Disturbing Organisms (PESTs) such as tea leafhoppers, tea ladybugs (Helopeltis theivora), jumping bugs, and aphids can cause young leaves to become damaged, turn yellow, dry out, and even die, resulting in significantly reduced quantity and quality of fine shoots. Pest control can use natural enemies of pests, such as insect predators, parasitoids, and entomopathogenic fungi. In addition, insecticides and fungicides can be sprayed with the principle ; right time, right dose, right method, and right target, to be effective and minimize chemical residues (Andisca, et al., 2021).

At the time of the wet analysis data collection, it was the rainy season, and high rainfall can have both positive and negative impacts. If the rainfall is even and not excessive, the shoots produced can be more abundant and meet MS standards. However, too much rain can damage the fine shoots and cause them to break before harvesting. In addition, high humidity can trigger the growth of fungi that can attack tea shoots, making them unfit for harvesting.

Conclusion

Based on the results of the wet analysis conducted, it is known that the yield of tea shoots does not always meet the minimum requirements to be categorized as Qualified Shoots (MS). Of all the daily data obtained, only day 9 and day 14 showed results that met the minimum requirements, with an average percentage of fine shoots of 29%. Overall, the daily averages of the percentage of fine shoots obtained during the observation period were 22%, 25%, 22%, 23%, 19%, 20%, 19%, 24%, 28%, 20%, 24%, 27%, 24%, 29%, and 19%. Some of the factors affecting the low percentage of fine shoots in the industry include improper harvesting methods, inappropriate picking rotation, suboptimal crop maintenance, and weather factors, especially high rainfall. Inappropriate picking techniques can be seen from the habit of harvesting old tea leaves, hard stems, or stems that are too long, which should not be included in the category of fine shoots. The ideal picking interval is every 10-12 days; if the picking interval is too long, the shoots tend to age and not meet quality standards. In addition, disruptions to plant growth due to pruning, inadequate fertilization, or pest attacks can also lead to reduced production of fine shoots. Heavy rainfall can damage young shoots and break them before they can be harvested. High humidity can also trigger the growth of fungi that attack tea shoots, making them unfit for harvesting. Therefore, efforts are needed to improve cultivation and harvesting techniques to ensure the quality and quantity of fine shoots in accordance with MS standards.

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