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ANALYSIS OF ORTHODOX BLACK TEA POWDER DENSITY USING THE TEA DENSIMETER METHOD AT PT PERKEBUNAN NUSANTARA I REGIONAL 2 KEBUN CIATER, KAB. SUBANG, PROV. WEST JAVA

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ABSTRACT

PT Perkebunan Nusantara I Regional 2 Ciater Plantation is engaged in the processing, management and marketing of black tea plantation products. The processing method used is the orthodox method, resulting in tea with a distinctive aroma and color. One of the quality control efforts on dry sorted tea products is the density test. Density is one of the indicators of tea quality control that affects the distribution and packaging process of tea powder. This study aims to determine the results of density analysis of orthodox black tea for 10 days, then determine the results of quality control with the P control map and determine the factors that cause density quality discrepancies. The method used in the density analysis of orthodox black tea is the tea densimeter method by tapping the powder 35 times. The result of powder density read in the measuring cup represents the volume of tea powder. The types of tea analyzed include BOPF, PFANN, Dust, PFANN II, Dust II and FANN II. The results showed that there were several deviations in the types of powder BOPF, PFANN, FII and Dust II which can be seen on the P control map. Factors that cause discrepancies in density values are the receipt and handling of raw materials. So it is necessary to do a good handling of raw materials by testing data worth processing in order to produce powder that meets the standards.

Keywords: Black tea, orthodox system, tea density, tea quality

Introduction

PT Perkebunan Nusantara I Regional 2 Ciater Garden is a company under the auspices of a State-Owned Enterprise engaged in the tea commodity with commodities in the form of orthodox black tea. The raw material used is Camelia sinensis tea type and the products produced and sold in the form of bulk tea. Camellia sinensis tea plant is one of the annual plants originating from subtropical regions, so it is more suitable for cultivation in mountainous areas in Indonesia (Adnan et al., 2013). Camellia sinensis is one of the most popular beverages worldwide and is highly valued for its unique flavor and health benefits (Wakamatsu et al., 2024). Tea quality is influenced by several factors, such as cultivation, picking standards, processing technology, and storage conditions (Zhu et al., 2019). The main components of tea shoots are polyphenols and caffeine whose levels are highest and decrease when the shoots are rough (Sanyal, 2011).

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Based on the processing, tea is categorized into several types, one of which is fermented black tea (Schillinger et al., 2010). This fermentation process in tea can enrich the polyphenol content (Aloo et al., 2024). Black tea is usually produced in two ways, namely orthodox and crushing-tearing-curling (CTC) (Po, 2016). The orthodox method involves the use of rollers and lighter manual rolling, while the CTC method involves maceration machines with a harsh degree of withering (Jolvis Pou, 2016). PT Perkebunan Nusantara I Regional 2 Ciater Garden in processing black tea uses traditional processing methods, namely the orthodox method. The advantages of processing black tea with orthodox methods are in the flavor and quality (Graham, 1992).

Quality control is the most important aspect and one of the critical points in maintaining the quality of a product. According to Gaspersz (2001), quality control is the process and actions taken to ensure products conform to the desired quality standards. The purpose of quality control is to quickly analyze the source of the problem and identify the cause of production discrepancies (Rocha et al., 2023).

Quality control carried out by PTPN I Regional 2 Ciater plantation is divided into several stages, one of which is quality control of the final powder, namely the tea density test. Tea density testing is a tea quality control parameter that is an important factor in tea processing. The tea density test affects the packing and distribution process. This is because it facilitates the process of transportation, warehousing and estimating packaging size, especially in export marketing. Density testing is carried out to measure the density (specific gravity) of tea powder (Salsabila *et al*., 2023).

Based on the above background, tea density testing is a very important tea quality parameter. This is because, if the density of tea is high, it will affect the packaging, causing the packaging height to exceed the specified capacity. So it is necessary to use a control map to determine the stability of the final quality density at PTPN I Regional 2 Ciater Garden. The objectives of the study were (1) to determine the results of the density analysis of orthodox black tea at PTPN I Regional 2 Ciater Kebun; (2) to determine the results of density quality control with a P control map; (3) to determine the factors that cause density quality discrepancies against quality standards at PTPN I Regional 2 Ciater Kebun.

Research Method

Density testing of orthodox black tea at PT Perkebunan Nusantara I Regional 2 Ciater Garden uses quality I tea powder materials, namely BOPF, PFANN, and Dust, then quality II powder, namely PF II, Dust II, and F II. The step of testing the quality of black tea density with the Tea Densimeter method is to weigh 50 g of each type of tea powder and put it into a 500 ml measuring cup, then knock 35 times. The results of the measurement of the density volume show the density value of each type of orthodox black tea, which is then recorded as an observation.

Density quality testing at PTPN I Regional 2 Ciater Plantation has quality standards for each type of tea powder, this is done to avoid deviations. The quality standards have been compiled and set in a standard

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operating procedure (SOP) which is based on the ISO 9001: 2000 Program reference. So that the quality standard is used as a control line in density testing with the tea densimeter method The density standards used by PT Perkebunan Nusantara 1 Regional 2 Ciater Plantation are shown in Table 1.

This study utilized primary and secondary data. Primary data was obtained from the research results, while secondary data came from interviews with the company regarding quality control of orthodox black tea on the density parameter. Data collection techniques in this study were direct observation and literature study. The density data analysis method needs to be evaluated to determine the cause of deviation with a control chart. According to Amarta dan Hazimah (2020), a control chart is a graph used to monitor changes in values over time. Quality measurement based on attributes is carried out using a P control map (Montogomery, 2008). Then the benefit of the P control map is to assist in product quality control and provide information on when and where the company should improve improvement and quality, whether the production process is still within the control limits or not (Salsabila et al., 2023).

Table 1. Quality standard of orthodox black tea density PT Perkebunan Nusantara I Regional 2 Kebun Ciater

Type	Tea Density Standard (50 g/cm^3)
BOPF	135–150
PFANN	130–145
DUST	122–137
PFANN II	125–140
FANN II	135–150
DUST II	115–130

Source: SOP PT Perkebunan Nusantara I Regional 2 Kebun Ciater

Results and Discussion

Density analysis of dry sorted tea powder at PTPN I Regional 2 Ciater Plantation, obtained data from the test results and observations for 10 days as a whole shown in Table 2.

Table 2. Data from density analysis of orthodox black tea for 10 days of testing

Date	Day	Density test results of orthodox black tea (50 g/cm^3)					
		BOPF	PFANN	Dust	PF II	Dust II	F II
12/02/2024	1	150	150	135	135	135	140
13/02/2024	2	145	145	125	140	120	155

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Date	Day	Density test results of orthodox black tea (50 g/cm³)					
		BOPF	PFANN	Dust	PF II	Dust II	F II
16/02/2024	3	150	145	125	130	125	160
17/02/2024	4	145	140	130	140	120	135
18/02/2024	5	145	140	125	135	115	145
20/02/2024	6	150	145	130	135	115	140
21/02/2024	7	155	150	125	140	125	135
22/02/2024	8	150	145	125	140	125	150
23/02/2024	9	150	145	125	140	120	150
24/02/2024	10	145	140	130	130	115	145

Based on Table 2 which shows the results of observations of the density of orthodox black tea, it is found that some results have deviations or discrepancies with the applicable density standards. So to find out information and evaluation of each type of tea, it can be tested by using the P control map. The results of the control map data for the BOPF type can be seen in Figure 1.

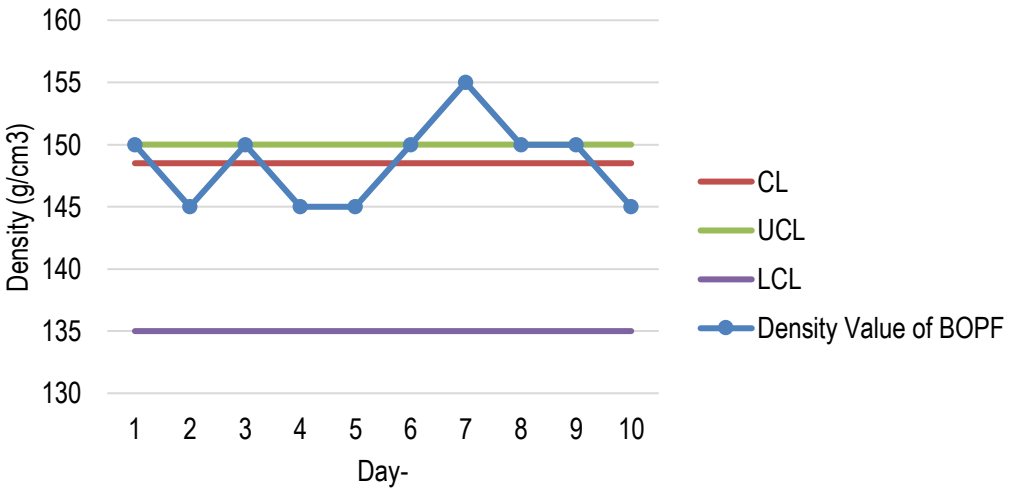

Figure 1. P-Chart control map of density of orthodox black tea type BOPF

Based on the p control map shown in Figure 1, it is known that there is a discrepancy in the density value on the 7th day of testing with a value of 155 g/cm³ and exceeds the UCL limit of 150 g/cm³. The factor that causes the density value to exceed the standard limit is that the powder particle size is too large. Particle size and density serve as an important basis for monitoring powder products (Prawira et al., 2019). So it is necessary to re-mix the powder with Tea Bin so that the packing process is in accordance with the applicable SOP standards. Density parameters have a relationship with planning packaging size, storage and distribution (Lumay et al., 2012).

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The next density analysis result is PFANN (Pekoe Fanning) powder type. PFANN tea powder is a powder that can pass through sieve 18 and stuck on sieve 22. This type of tea powder is a grade I quality powder whose particles are black in color with a small and coarse grain texture. PFANN powder has a quality standard density between 130-145 g/cm^3. The P-Chart control map of PFANN tea density test results is shown in Figure 2.

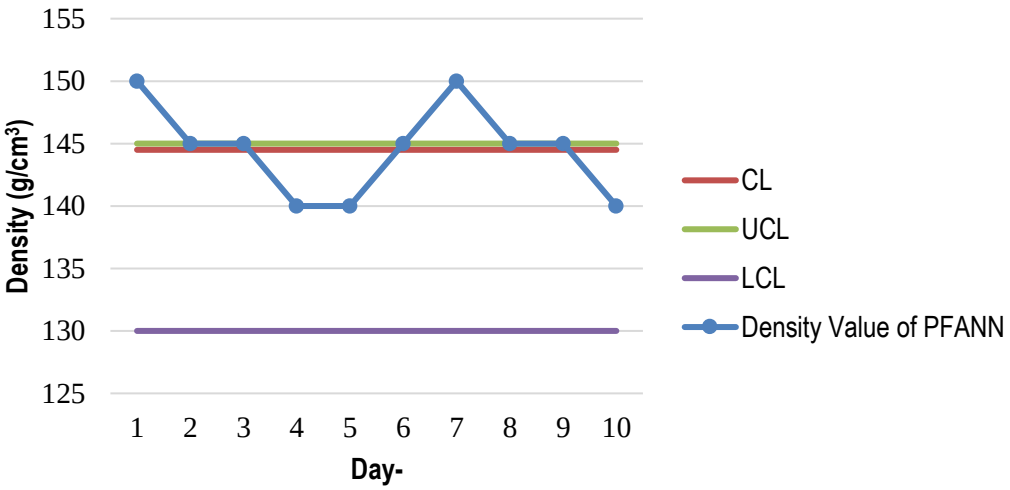

Figure 2. PFANN type orthodox black tea density P-Chart Control Map

Based on Figure 2, the P-Chart control map of the density of PFANN orthodox black tea for 10 days of testing, shows that there are values that are outside the control limits, it is found that on the 1st and 7th days there is a discrepancy and exceeds the UCL limit of 145 g/cm3, but there is no data that exceeds the LCL limit of 130 g/cm3. Possible factors affecting the density value of PFANN tea not meeting the standard are unstable drying process and powder particles that are too large. Drying in tea processing plays an important role in determining quality (Purba et al., 2021). Drying time also affects the moisture content of the dried powder. The longer the drying process, the more heat is absorbed by the material. As a result, the amount of water that evaporates from food ingredients is also increasing, so that the water content in the material is getting lower (Winarno, 1995). This causes the value of moisture content in tea powder to be inappropriate.

The next density analysis test is Dust powder. Dust type tea is a quality I powder with a slightly reddish black color that has a soft texture and passes mesh 22 and is stuck on mesh 40. According to (Martin, 2007), Dust powder is the dregs left over from the tea making process and includes pieces of tea leaves. Dust powder has a density quality standard between 122-137 g/cm3. The control chart of the results of the Dust type tea density test can be seen in Figure 3.

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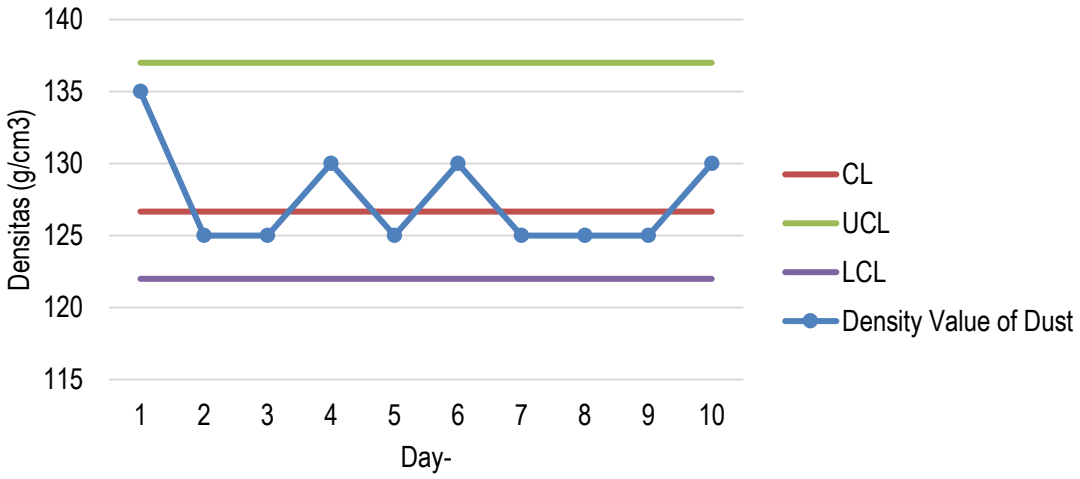

Figure 3. Dust type orthodox black tea density P-Chart Control Map

Based on the P control map shown in Figure 3, it is found that the highest density value in the Dust powder test was obtained on day 1 of 135 g/cm^3 and during the 10 days of testing there were several decreases and increases in density, but the density data is still within the control limits or in control and does not cross the UCL 137 g/cm^3 and LCL 122 g/cm^3 limits. The factors that cause the density value of Dust type to comply with the standard are humans and raw materials. The quality of tea buds affects the final quality of the product. The better the quality of the shoots, the results obtained will meet the set standards (Immanniaty & Juwitaningtyas, 2022).

PFANN II type tea is a tea powder in quality category II which has a characteristic brownish black color with a softer powder particle texture than PFANN. PFANN II powder is a powder derived from leaf fiber pieces with a small size that is uniform with powder II. The density quality standard for PFANN II powder has been set with the SOP which is around 125-140 g/cm^3. The control chart of PFANN tea density analysis results is shown in Figure 4.

The P control map in Figure 4 shows that the lowest density value in the PF II powder test was obtained on the 3rd and 10th days at 130 g/cm^3, and during the 10 days of testing there were several decreases and increases in density values, but the data remained within the control limits or in control and did not exceed the UCL limit of 140 g/cm^3 and LCL 125 g/cm^3.

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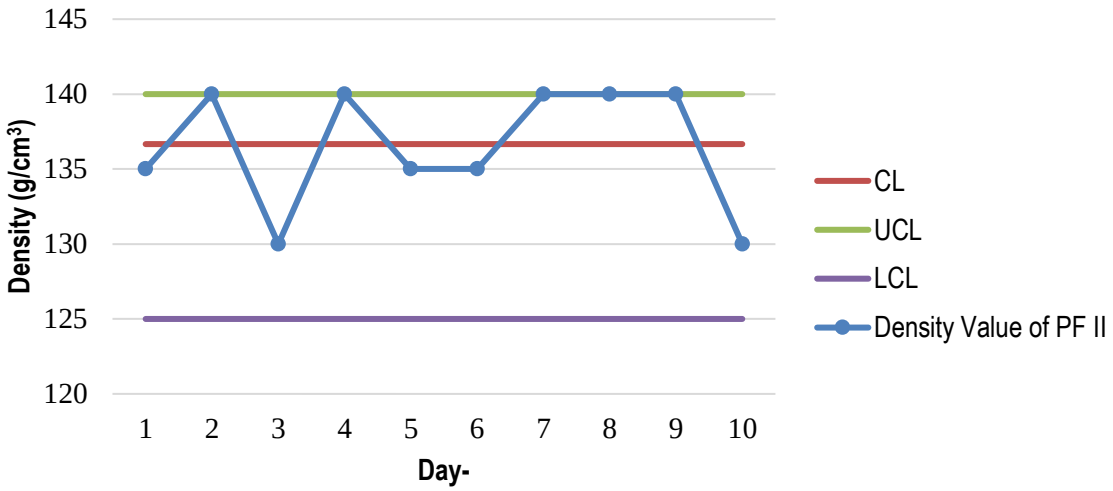

Figure 4. PFANN II type orthodox black tea density P-Chart Control Map

The next density analysis test is Dust II powder. Dust II type tea has a characteristic reddish black color with fine powder particles and passes through mesh 12 but cannot pass through mesh 60. Dust II powder comes from powder II from dry sorting on line 2 and has a density quality standard between 115-130 g/cm^3. The control chart of the Dust II density test results can be seen in Figure 5.

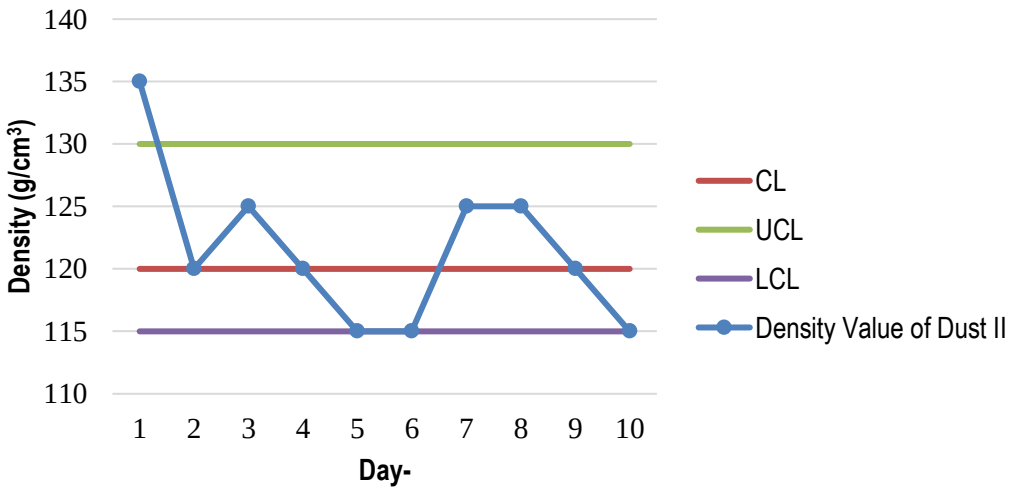

Figure 5. P-Chart control map of density of orthodox black tea type Dust II

The P control map in Figure 5 shows that the results of the Dust II powder density analysis during the 10-day test period have deviations. From the data in Table 2, it is found that day 1 has a density value above the quality standard of 135 g/cm^3 and exceeds the UCL upper control limit of 130 g/cm^3. The factor that causes the density value of Dust II type tea powder is the uneven powder particles, so it is necessary to re-mix the powder

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type. This is supported by the research of Sinaga et al. (2023), stating that the sorting process must be mixed using a tea bulker that is suitable for each type of powder to produce the appropriate size.

Fanning (FANN) II tea powder is a powder in quality grade II produced from powder II from sorting lane 2. FANN II tea has a reddish brown powder with a slightly coarser texture than PF powder and can pass on mesh 18 but is stuck on mesh 22. The quality standard for FANN II powder density can be seen in Table 1. The P-Chart Control Map of FANN II tea density test results can be seen in Figure 6.

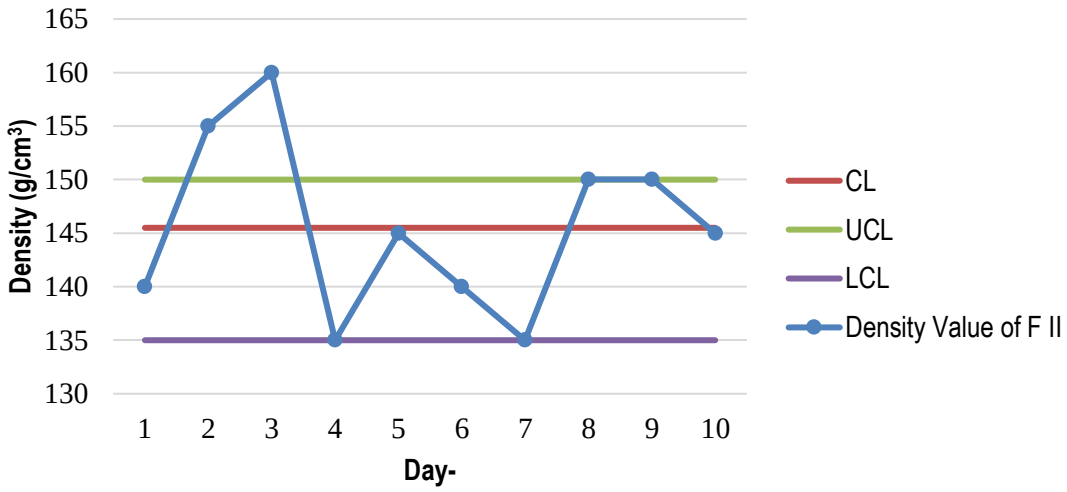

Figure 6. P-Chart control map of density of orthodox black tea type FANN II

The results of the P control map shown in Figure 6 show that the density values that experienced deviations occurred on days 2 and 3, namely 155 g/cm^3 and 160 g/cm^3. This indicates that the data generated is outside the UCL limit of 150 g/cm^3. Values that do not meet the standard can be caused by several factors, including the drying process that has not been stable and the sorting process that has not been maximized, so that the FANN II type powder needs to be improved so that the packing process can run according to the SOP standard.

Density quality control for powders that experience discrepancies or exceed standard limits can be controlled with a P control map. This is in accordance with the theory of Annisa (2021), which states that the P control map can be used in product quality control and helps determine information in making quality improvements for defective products. Good quality control can be seen from the data graph. If the data is within the control line limits, the process is considered statistically under control. However, if the data is outside the control line limits, then quality control is not optimal (Sinaga et al., 2023).

Based on the density data of black tea powder testing results for 10 days, there are some data that exceed the quality limits set by the SOP (see Table 1). Density measurements use the Tea Densimeter method or tap

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with a measuring cup that refers to the factory standards, namely SOP and ISO 9001: 2000. Analysis of the P control map indicated the presence of errors or deviations from the control limits. Therefore, the problematic tea powder needs to be repaired or re-mixed in the tea bulker so that the packing and packaging process complies with the factory standard.

The particle size of tea powder is influenced by the raw materials. Quality raw materials come from young tea shoots, while poor raw materials consist of old tea stem leaves, resulting in a tea powder size that does not meet the standard. The higher the density of the tea, the larger the size of the tea powder obtained. Conversely, low density results in smaller size. The size reduction process in tea powder production is an important stage, because it will produce powder that meets the standard. Supported by the theory of Barbosa-Canovas et al., (2005), states that powder particle size is used to classify powder products. Deviations in the density of orthodox black tea powder at PT Perkebunan Nusantara I Regional 2 Ciater Garden can be caused by several factors:

a. Man

The influence of labor on black tea quality is significant. Workers' lack of understanding of the process from raw materials to production can lead to quality deviations. In addition, worker fatigue also affects performance. According to Tarwaka (2004), fatigue can reduce work capacity and efficiency.

b. Method

Tea density deviations can be caused by ineffective processing methods. Factors such as picking tools that do not meet standards and the absence of fresh shoot sorting can lead to a mixture of weeds, twigs, and insects in the processing process. Pickers tend to focus more on quantity than quality, which reduces the quality of tea (Dewi & Purnomo, 2019). Plucking analysis and shoot analysis are needed to evaluate the type of plucking and quality of shoots to be processed (Ferdiansyah *et al*., 2023). Efforts to increase tea production and quality can be achieved by improving the plucking system to be more efficient and produce optimal results (Nazaruddin & Paimin, 1993).

c. Machine

The machinery used in the processing process affects tea density and quality. Density discrepancies can be caused by drying machines (FBD) and sorting machines. Unstable drying temperature affects the efficiency of the process. During the drying process, high temperatures can cause burnt powder, while drying at low temperatures results in semi-dry powder (Owuor & Orchard, 1992). In line with the research of Kushwahaa et al. (2015) who stated that unstable temperature will reduce powder quality and affect powder shape.

d. Material

Tea raw materials are the main factor affecting product density. The condition of raw materials that do not meet standards such as unfulfilled APLO, old tea shoots, and weeds that are carried away

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in processing can cause the size of the tea to not meet the standard, so that the density is lower or higher than the standard.

The main cause of density value discrepancies is in the receipt and handling of raw materials. At this stage, the raw material is usually damaged, accompanied by a lot of weeds and insect contamination, then the lack of the number of peko and young leaves that are suitable for processing. So it is necessary to carry out picking standards to produce quality raw materials and can avoid the risk of product defects (Pou et al., 2019).

Another factor that needs attention is the handling of tea powder that falls to the floor during the sorting process. Tea powder that is collected and put back into the sorting machine can be physically contaminated by dust or other particles. This can increase the moisture content of the tea powder, resulting in a higher density value. As a hygroscopic product, tea can absorb moisture from the environment (Teshome, 2019), which can affect the shelf life and quality of the product if the moisture content increases (Adnan et al., 2013).

Based on several factors causing the discrepancy of density values in orthodox black tea powder, there are several recommendations for improvement proposals presented in Table 3.

Table 3. Recommended quality improvement measures for orthodox black tea density

Causative Factors	Improvement Recommendations
Receiving and handling raw materials	Increased supervision of workers by the foreman on duty, as well as adding manual pickers and increasing foreman supervision of pickers using machines.
Handling of dry sorted tea powder	Supervision and control of workers on tea powder that falls to the floor by the sorting foreman so that repairs are made.
Drying process at unstable temperature	Conduct temperature monitoring and supervision of the drying process, then implement a disciplined work system with SOP.

Conclusion

The conclusion from the analysis and practical work at PTPN I Regional 2 Ciater plantation obtained the results of quality handling carried out using the P-Chart control map shows that there are several types of tea powder that are outside the control limits, namely the type of BOPF powder on day 7, then PFANN on days 1 and 7, FII powder on day 1 and Dust II on days 2 and 3, so that improvements need to be made. Then the factors that cause non-conformity in the density value of tea powder at PTPN I Regional 2 Ciater Garden are

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less than optimal handling and receipt of raw materials, inappropriate handling of dry sorted tea powder that falls to the floor and unstable drying temperatures. So, stricter supervision of foremen and disciplined work improvement in implementing SOP are needed.

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