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Analysis of Moisture Content Based on Grade Using Grand Moisture Texture in the Green Tea Processing

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ABSTRACT

Moisture content is an important parameter in controlling the quality of dried tea. The moisture content in dried tea can affect the shelf life, texture, and organoleptic quality of the product, such as the color, taste, and aroma of the tea produced. Moisture content analysis is carried out after the drying process and before the sorting process, and moisture content testing is performed using a Grand Moisture Texture. The analysis was conducted on 3 grades with 8 types of dried green tea. Grade I consists of Peko Super Besar, Peko Super Kecil, and Chun Mee. Grade II consists of Keringan-2, Lokal-2, and Kempring. Grade III consists of Dust and Tulang. Samples were tested three times a day, and the average was calculated with a total of 10 data points for each type. The methods used in the analysis of the moisture content of dried green tea were Control Chart and Boxplot. The Indonesian National Standard, namely SNI used as a reference was SNI 3945: 2016. The average moisture content analysis results obtained for Grade I Peko Super Besar were 4.6%, Peko Super Kecil 4.8%, and Chun Mee 5.8%. For Grade II Keringan-2, the results were 6.3%, Lokal-2 5.6%, and Kempring 6.3%. The Grade III Dust was 6.6% and Tulang was 6.4%. On average, there were no deviations from the 10 data points, but there was 1 data point in the Grade III Dust type that exceeded the SNI regulation. The deviation in moisture content in dried green tea was caused by the transfer period during production and the type of packaging.

Keywords : *Boxplot, Control Chart, Green Tea, Moisture Content*

Introduction

Indonesia is the sixth largest tea producer in the world. Tea is classified into three types based on its processing method: green tea, black tea, and oolong tea (Effendi et al., 2017). Green tea is processed through repeated steaming and drying of tea leaves without undergoing fermentation. Green tea contains high levels of catechins, giving it strong antioxidant properties (Fahmi et al., 2022). High-quality products are produced through high-quality processes, which means consistent quality control standards so that the resulting products have high quality. Quality control processes can be implemented from raw materials to the final product ready for distribution to consumers. The health benefits of tea stem from its bioactive compounds, particularly polyphenols, which are most abundant in tea leaves. Generally, polyphenols are classified into two main groups: flavonoids and phenolic acids. Flavonoids are the most dominant group of polyphenol compounds. These compounds play a role in preventing cardiovascular diseases by inhibiting the oxidation of fats in the body (Sudaryat et al., 2015).

Moisture content is an important quality control parameter for determining the quality of dried tea products (Putri et al., 2021). The moisture content of fresh tea leaves is 75%, with the remaining 25% consisting of organic

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and inorganic solids. After processing, the moisture content of dried tea leaves ranges between 4-6% (Sylvi et al., 2021). Moisture content is a critical parameter in determining the quality and shelf life of food products, including tea powder. The purpose of measuring the moisture content in dried green tea is to prevent the moisture level from exceeding the predetermined standards, as this would accelerate the growth of microorganisms, chemical reactions that degrade bioactive compounds, and a decrease in sensory quality such as aroma and taste. An excessively low moisture content can also affect the physical characteristics of the product, such as hardness and brittleness (Fikriyah & Nasution, 2021).

The moisture content of dried green tea used as a standard complies with SNI 3945:2016, which specifies a maximum of 8% (Atmaja et al., 2021). If the moisture content exceeds the specified standard, re-drying will be performed or a blending process can be carried out with previous or subsequent production batches to neutralize the moisture content so that it meets the company's established moisture content standard. The purpose of researching the moisture content in dried green tea is to maintain the quality, durability, and safety of the product by determining the accuracy of the moisture content in dried green tea in accordance with the standards set by the tea industry. High moisture content in dried tea can cause bacteria to grow more rapidly, thereby damaging product quality (Fikriyah & Nasution, 2021).

Research Method

Statistical Process Control (SPC)

Statistical process control is the process of monitoring, controlling, analyzing, managing, and improving a product with the aim of solving problems within an industry. Statistical process control is a quality control process that uses quantitative data during production by sampling products and evaluating the results to control production outcomes.

Seven Tools

The seven tools are aids for identifying the causes of a problem by illustrating the problem and organizing data to make it easier to understand and use to improve the quality of industrial products. The seven tools used to solve problems consist of Check Sheets, Histograms, Control Charts, Pareto Diagrams, Cause-Effect Diagrams, Scatter Diagrams, and Process Diagrams. The advantages of the seven tools are that they are structured in problem solving, can determine strategies for solving problems, and support problem solving by developing thinking about the problems faced.

Control Chart

Control chart is a graphical tool used to monitor and evaluate whether a process is under statistical quality control or not, thereby enabling problem solving and quality improvement. A control chart relies on three lines: the Upper Control Limit (UCL) as shown in Equation 1, the Central Line (CL) as shown in Equation 2, and the Lower Control Limit (LCL) as shown in Equation 3.

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UCL = x + (3σ) Equation 1.

CL = x Equation 2.

LCL = x - (3σ) Equation 3.

Cuase-Effect Diagram

A cause-effect diagram (Fishbone Diagram) is a graphical technique used to organize and connect several interactions with the influencing factors in a process. The analysis process is divided into several categories related to the process, the human activities, material aspects, machine performance, and the flow of procedures. The advantages of the fishbone diagram are that it is easy to read, helps identify the causes of problems that affect productivity, can increase productivity, and enhances both internal and external communication in the industry.

Moisture Content Analysis

The Grand Moisture Texture tool using the dielectric method operates based on the principle of detecting moisture in a sample without damaging it. The higher the moisture content in the sample, the higher the dielectric constant of the material, and the measuring device can detect these changes to accurately determine the moisture content. This method is fast, non-destructive, and suitable for real-time measurements in the tea industry or other materials requiring optimal moisture control. This method is applicable to all grades of dried green tea, as shown in Table 1. To use the Grand Moisture Texture, turn it on by clicking the ON button, then click the MEA button until the word “POUR” appears. Place the green tea leaves into the device using the scoop provided until it is full and level, then wait for the moisture content percentage to appear on the Grand Moisture Texture device screen.

Table 1. Types of Green Tea Grades in Industry

Type	Grade I	Grade II	Grade III
1	Peko Super Besar	Keringan-2	Dust
2	Peko Super Kecil	Lokal-2	Tulang
3	Chun Mee	Kempring	-

Results and Discussion

The control chart analysis based on data collected 10 times over a period of 28 days in the green tea production process shows that the moisture content data in dry Grade I green tea showed no deviations. The average moisture content for the Peko Super Besar type is 4.6%, for the Peko Super Kecil is 4.8%, and for Chun Mee is 5.8%, which is in accordance with the Indonesian National Standard, namely SNI for green tea 3945:2016, which states that the maximum moisture content is 8% (Atmaja et al., 2021).

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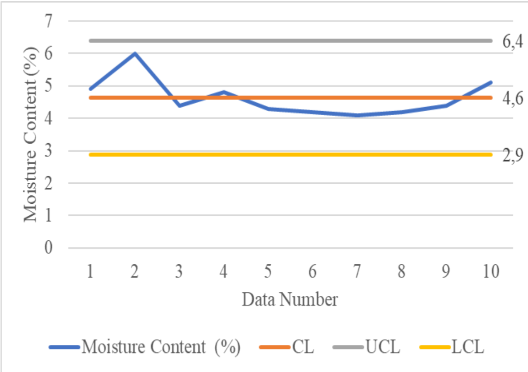

Figure 1. Moisture Content of Grade I of Peko Super Besar Type

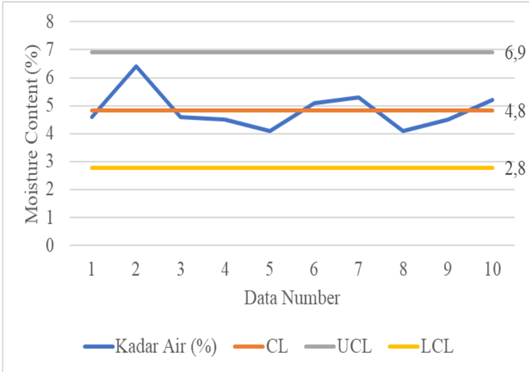

Figure 2. Moisture Content of Grade I of Peko Super Kecil Type

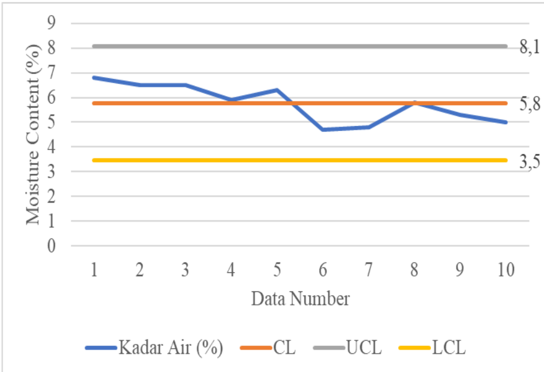

Figure 3. Moisture Content of Grade I of Chun Mee Type

The control chart analysis based on data taken 10 times over a period of 28 days during the green tea production process indicates that there are no deviations in the moisture content of Grade II dry green tea. The average moisture content for the Keringan-2 type is 6.3%, 5.6% for Lokal-2, and 6.3% for Kempring, which complies with the Indonesian National Standard, namely SNI for green tea 3945:2016, which states that the maximum moisture content is 8% (Atmaja et al., 2021).

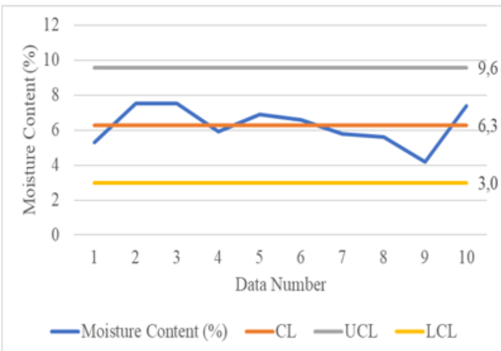

Figure 4. Moisture Content of Grade II of Keringan-2 Type

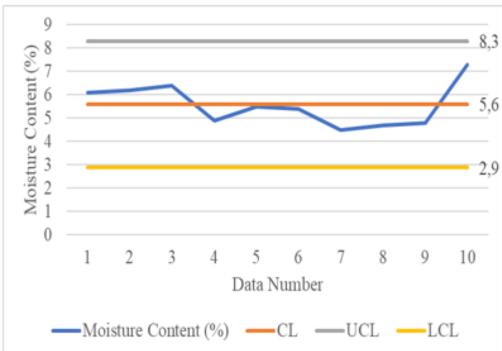

Figure 5. Moisture Content of Grade II of Lokal-2 Type

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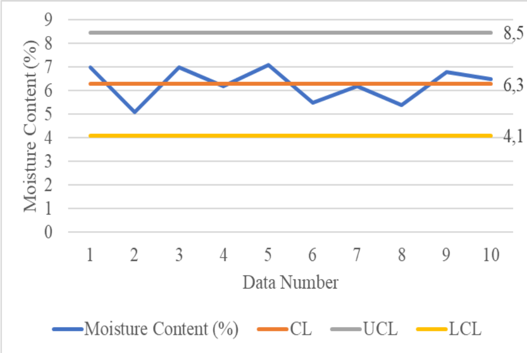

Figure 4. Moisture Content of Grade II of Kempring Type

The control chart analysis based on data collected 10 times over a period of 28 days in the green tea production process shows that there were no deviations in the moisture content data for Grade III dry green tea. The average moisture content for the Dust type was 6.6% and for the Tulang type was 6.4%, which is in accordance with the Indonesian National Standard, namely SNI for green tea 3945:2016, which states that the maximum moisture content is 8%. However, for the Dust type dry green tea, the third data point showed a deviation as it exceeded the SNI limit of 8.4% (Atmaja et al., 2021).

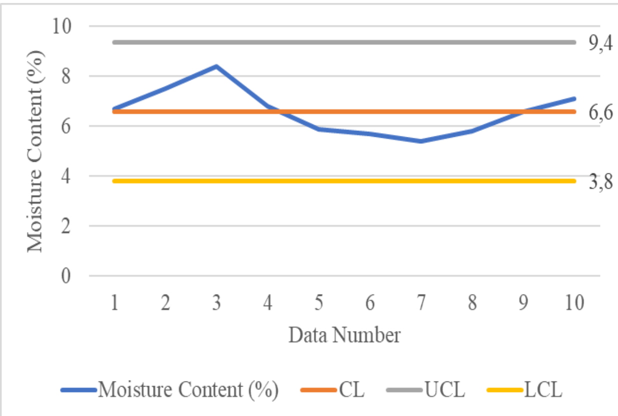

Figure 5. Moisture Content of Grade III of Dust Type

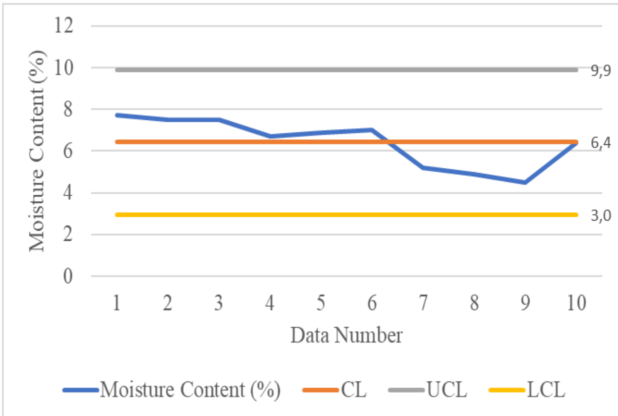

Figure 6. Moisture Content of Grade III of Tulang Type

Table 2. The Result of the Suitability Moisture Content of Dried Green Tea

No	Grade	Type	Suitability
1.	Grade I	Peko Super Besar	Suitable
		Peko Super Kecil	
		Chun Mee	
2.	Grade II	Keringan-2	Suitable
		Lokal-2	
		Kempring	
3.	Grade II	Dust	Suitable
		Tulang	

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The Boxplot data generated from the LCL (Lower Control Limit) values for each type of the three Grades, as shown in Figure 9, indicates that for dried green tea Grade I, the Q1 value is 2.84%, the Q2 value is 2.9%, and the Q3 value is 3.2%. For dried green tea Grade II, the Q1 value is 2.95%, the Q2 value is 3%, and the Q3 value is 3.55%. For dried green tea Grade III, the Q1 value is 3.2%, the Q2 value is 3.4%, and the Q3 value is 3.59%.

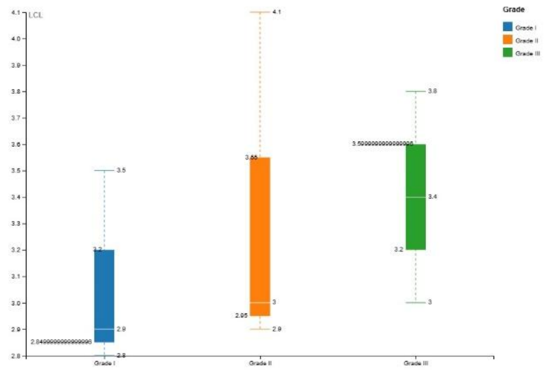

Figure 7. Boxplot LCL of Dry Green Tea Moisture Content

The Boxplot data generated from the UCL (Upper Control Limit) values for each type of the three Grades, as shown in Figure 2.19, indicates that for Grade I dry green tea the Q1 value is 6.65%, the Q2 value is 6.9%, and the Q3 value is 7.5%. For Grade II dry green tea, the Q1 value is 8.4%, the Q2 value is 8.5%, and the Q3 value is 9.05%. For Grade III dry green tea, the Q1 value is 9.52%, the Q2 value is 9.65%, and the Q3 value is 9.77%.

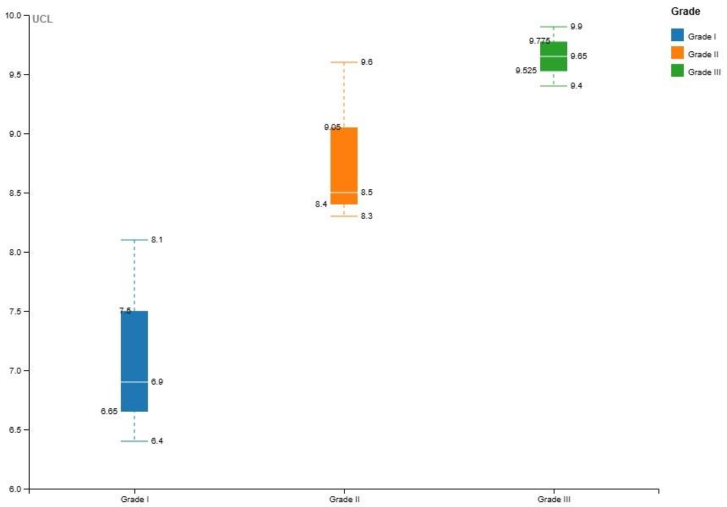

Figure 8. Boxplot UCL of Dry Green Tea Moisture Content

Based on the analysis of the LCL (Lower Control Limit) and UCL (Upper Control Limit) values for each grade above, namely Grade I, Grade II, and Grade III, it can be concluded that the higher the grade of dried

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green tea, the better the quality will be, as a higher moisture content can lead to the growth of mold and microorganisms. This will affect the shelf life of dried green tea, making it shorter and more susceptible to quality degradation, such as color, aroma, and taste of the brew.

The reason why higher grades have better quality is that Grade I predominantly consists of Peko Super or tightly rolled and perfectly shaped tea leaves after the drying process. Grade II contains Peko Super but in a minority as it has been mixed with Kempring, which are slightly finer tea leaf fragments, and the majority of Grade II composition consists of leaves or buds that have stopped producing new shoots. Grade II has Peko Super, but its quantity is minimal because it has already mixed with Kempring, which is a fine shred of tea leaves, and the majority composition of Grade II is bird leaves or buds that are no longer actively producing new shoots. Therefore, after the drying process, the result is not perfectly rolled and not dense. Grade III consists of Dust and Tulang originating from bird leaves. The moisture content of tea bud leaves is lower compared to bird leaf buds, due to the fact that the cell structure of bird buds is not dense (Wijayanto et al., 2015). The loose structure creates more space to hold water, and bird buds are not actively producing new shoots, resulting in low metabolism and the absorbed water is only stored.

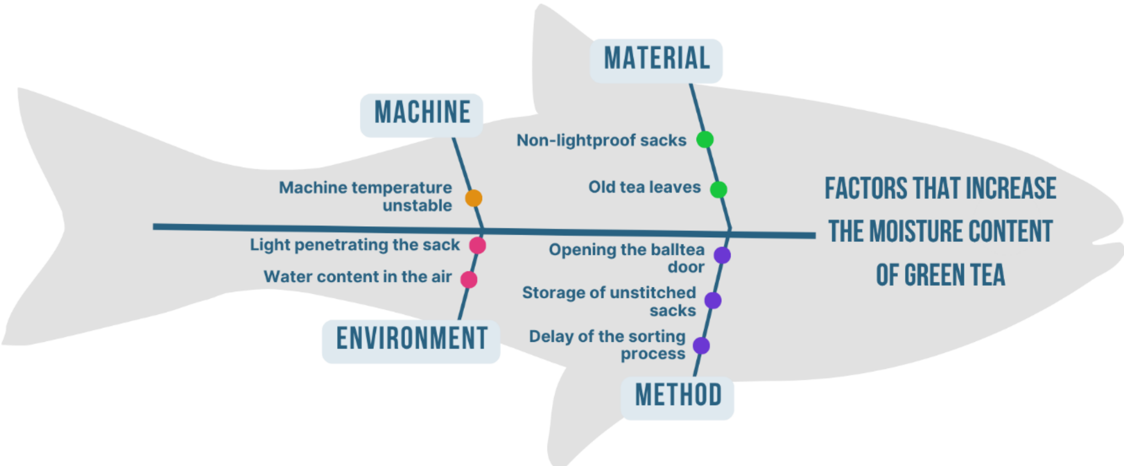

Figure 9. Fishbone Diagram for Increasing the Moisture Content of Green Tea

The factors causing deviations in moisture content in dry green tea exceeding the Indonesian National Standard, namely SNI for green tea 3945:2016 shown in the figure can be attributed to several reasons. Here are some factors that lead to deviations in moisture content in dry green tea:

1. Material

The material factor of older tea leaves that are picked contributes to deviations in moisture content because they have a more fibrous leaf structure and a lower initial water content compared to younger buds. When processed together, older leaves tend to dry more slowly due to their higher lignin and cellulose content compared to younger leaves. This inconsistency causes some products to retain higher moisture levels. Non-

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lightproof sacks will cause an increase in temperature inside the sacks or humidity inside the sacks will increase, resulting in more active water vapor in the air, which will then be absorbed by the dry tea, leading to an increase in moisture content.

2. Machines

In green tea processing, temperature stability is crucial during the withering and drying processes. Unstable temperatures can cause inconsistencies in the rate of water evaporation from the tea leaves. If the temperature is too low, the drying process will not be optimal, conversely, if the temperature is too high, water may evaporate too quickly from the outer surface of the leaves while the interior remains moist. This imbalance leads to non-uniform final moisture content, which can encourage microbial growth during storage.

3. Method

The method of opening the Balltea machine door while still hot can cause sudden differences in pressure and temperature, leading to condensation of water vapor on the surface of the dried tea leaves. This condensation increases the moisture content, in addition to reducing the drying efficiency because the leaves reabsorb the evaporated water. Bags that are not tightly closed allow outside air to enter, which also brings moisture. Tea powder is hygroscopic or easily absorbs moisture from the air, so the moisture content in the tea powder will increase. If the sorting process is delayed and green tea remains in an open environment, the dried tea leaves will be exposed to air containing free moisture for a longer time, thereby absorbing more water from the air and increasing the moisture content.

4. Environment

Environmental factors leading to deviation include direct exposure to light which can cause an increase in humidity within the bag. This activates photothermal reactions that can trigger an increase in internal humidity and the adsorption of water vapor onto the surface of tea leaves. Compounds in tea that are hygroscopic or absorb free water present in the air can enter through the gaps of the sack, such as polysaccharides, amino acids, and phenols, which have polar groups that form hydrogen bonds with H_2O molecules. This causes the moisture content to rise even though the drying process has been carried out previously.

Conclusion

The results of analysing the moisture content of dry green tea compared to SNI 3945:2016 for Grade I type Super Big Peko was 4.6%, Small Super Peko was 4.8%, and Chun Mee was 5.8%, indicating no deviation. Grade II type Keringan-2 was 6.3%, Lokal-2 was 5.6%, and Kempring was 6.3%, indicating no deviation. Grade III type Dust was 6.6% and Bone was 6.6%, indicating no deviation. The results of the boxplot analysis using UCL and LCL values showed that the higher the Grade, the lower the moisture content, and the lower the Grade, the higher the moisture content. Factors affecting the increase in moisture content of dry green tea include non-uniform raw materials, delays in processing, environmental humidity, and the type of packaging used.

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