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Postharvest handling and processing of coffee beans at UKM Akarosta, Tana Toraja Regency

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ABSTRACT

Postharvest handling and coffee processing must be carried out based on SNI standards to produce good quality and to increase selling value. In Tana Toraja Regency, there are various UKM engaged in the coffee processing industry but not many have analyzed the quality of the coffee produced. The purpose of this research is to know the postharvest handling and processing of coffee bean at UKM Akarosta and compare the proper postharvest handling process of coffee beans based on SNI standards. The results showed that the postharvest method carried out by farmers in Pasang Village, South Makale District, Tana Toraja Regency is a semiwash method which included harvesting, sorting, peeling fruit skins, washing, drying then stripping horn skins, sorting, roasting, grinding and packaging by UKM Akarosta. The postharvest process carried out by farmers has met with SNI. The quality of the coffee beans produced has met the SNI standard quality of coffee beans No. 01-2907-2008 and SNI quality of coffe powder No. 01-3542-2004.

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1. INTRODUCTION

Coffee is one of the leading commodity products of the plantation sector which has an important role in economic growth, as seen from the high demand for coffee. Coffee has many promising prospects for cultivation in Indonesia. Coffee comes in many varieties, with Arabica and Robusta coffee from Toraja being among the favorites of the Indonesian people. According to data from BPS Tana Toraja in 2022, the area of coffee cultivation development reached around 10,671.5 hectares with total coffee production reaching 3,567.82 tons. Toraja coffee has a distinctive taste and aroma that is different from other types of coffee so that Toraja coffee has national and international competitiveness, this also triggers high coffee production in Toraja [1].

The types of coffee cultivated in Toraja are robusta coffee (Coffea canephora) and arabica coffee (Coffea arabica). According to statement of Siacahyo & Poerbatanoe [1], robusta coffee can grow at an altitude of 600 meters above sea level, in contrast to arabica coffee which must be planted at an altitude of 1000 to 2000 meters, where the higher the planting location, the better the quality of the coffee produced. In general, the processing of arabica coffee and robusta coffee is the same, but to maintain the quality of coffee beans, various aspects need to be considered. Coffee processing in Toraja is still not fully maximized so that it has not had a significant impact on the community, until now.

The success of coffee products requires the help of various parties involved in processing and marketing coffee. The quality of coffee production is seen from the quality of the coffee which is in accordance with SNI standards. Apart from that, the quality is seen from the chemical and physical properties, including water content, green bean size, color, pH and ash content. According to statement of Yokawati & Wachjar [2], postharvest problems in coffee production in general occur during the post-harvest process and improper coffee processing, which affects the quality of the coffee. Therefore, to get quality coffee beans requires proper postharvest handling and coffee processing.

The purpose of this study is to determine the postharvest handling process and processing of coffee beans at UKM Akarosta and to compare the proper postharvest handling process of coffee beans based on SNI

standards.The usefulness of this research is expected to provide information on proper postharvest handling and processing of coffee beans and provide information on the effect of postharvest management on coffee quality.

2. MATERIALS AND METHODS

2.1 Time and Place

This research was conducted from April to May 2023 at UKM Akarosta, Merdeka Street, Makale, Tana Toraja Regency, South Sulawesi, Processing Laboratory, Agricultural Engineering Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University, Makassar and Chemical Analysis and Food Quality Control Laboratory, Food Science and Technology Study Program, Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University, Makassar.

2.2 Tools

The tools used in this research are grain moisture meter AMT65, roasting machine, oven, furnace, desiccator, porcelain cup, aluminum foil, water bath, beaker glass, pH meter, colorimeter, sieve, analytical scales, laptop, stopwatch and stationery.

2.3 Material

The material used in this research are arabica coffee, robusta coffee and distilled water.

2.4 Treatment and Parameters

This study used five treatments: water content, green bean size, color, pH ash content. Coffee beans are roasted at varying temperatures, could be categorized into three distinct levels. Arabica coffee beans are treated with light roast (205 ℃), medium roast (210 ℃) and dark roast(215 ℃) while robusta coffee beans are treated with light roast (210 ℃), medium roast (215 ℃) and dark roast (220 ℃).

2.5 Research Procedure

The method used in this research consists of field data collection stages and data analysis stages. The research stages are as follows:

2.4.1 Collection Data

Primary and secondary data were collected from harvesting at the farm level to processing and distribution of coffee beans at UKM Akarosta. Primary data collection is done through direct observation and interviews at the farm level and with owners of UKM. Meanwhile, secondary data collection can be obtained from the Central Bureau of Statistics and the Ministry of Agriculture.

2.4.2 Coffee Quality Testing

Coffee quality testing is carried out with reference to the Indonesia National Quality Standard (SNI) of coffee beans No. 01-2907-2008 and ground coffee No. 01-3542-2004. Sampling was carried out using a random sampling method while the types of coffee used were arabica coffee and robusta coffee. Parameters observed in testing the quality of coffee are water content, green bean size, color, pH, ash content.

2.4.3 Water Content

2.4.3.1 Water Content of Green Bean

Moisture Content of green bean moisture content is done by inserting green beans that have been taken randomly into the AMT65 moisture meter, measurements are taken three times.

2.4.3.2 Water Content of Ground Coffee

Determination of moisture content in ground coffee is done using an oven. A total of 2 grams of ground coffee was weighed and then put into the oven at 105 ℃ for 3 hours and then cooled in a desiccator, the sample was then weighed. The moisture content of ground coffee is calculated using the equation [3].

$$\text{Water Content (\%)} = \frac{W}{W1} \text{ x } 100\% \qquad (1)$$

where W is sample weight before drying (grams), W1 is loss of sample weight after being in the oven (grams).

2.4.3.3 Size of Green Bean

Based on SNI standards, green bean sizes are grouped into three sizes, namely large, medium and small. Three kilograms each of arabica coffee green beans and robusta coffee green beans were weighed and then sieved using 3 sieves each with different holes and diameters in accordance with SNI No. 01-2907-2008, where for robusta green beans a sieve with a diameter of 7.5 mm, 6.5 mm and 5.5 mm is used, while for arabica green beans a sieve with a diameter of 6.5 mm, 6 mm and 5 mm is used.

2.4.3.4 Color

Color measurements on arabica coffee beans and robusta coffee beans were carried out after the roasting process which was divided into three roast levels, namely light roast, medium roast and dark roast. Color measurements in coffee beans will be observed by measuring the L*, a*, b* and C (chroma) values using a colorimeter, where the C value must be calculated using the equation:

$$C = \sqrt{a^2 + b^2} \quad (1)$$

Where A is C is chroma value, a is indicator value a and b is indicator value b.

$$\Delta E = \sqrt{(L0 - L1)^2 + (a0 - a1)^2 + (b0 - b1)^2} \quad (2)$$

Where ΔE is total color change, L is brightness of the material, a is indicator value a and b is indicator value b

2.4.3.5 pH Measurement

Measurement of pH in arabica and robusta coffee brews is based on three roast levels, measurements are carried out in a ratio of 1:18 (short chain carboxylic acids, SCCA), namely 10 grams of ground coffee are dissolved in 180 ml of distilled water which has previously been heated, the sample is then measured using a pH meter that has been previously calibrated.

2.4.3.6 Ash Content

Ash content is defined as the amount of minerals in a material. Ash content measurements were carried out using the gravimetric method. Based on the roast level, each arabica and robusta coffee sample was weighed at 3 grams, placed in a furnace at a temperature of

600 ℃ for 5 hours, before being weighed, the sample was cooled in a desticator for 30 minutes. Ash content is calculated using the equation [4].

$$\text{Ash Content (\%)} = \frac{(W1 - W2)}{W} \text{ x } 100\% \quad (3)$$

Where W is sample weight before ashing (grams), W_1 is weight of sample + cup after ashing (grams), W_2 is weight of empty cup (grams).

2.4.4 Data Processing

Data processing was carried out using two applications, namely Microsoft Excel and IBM SPSS. Data processing on IBM SPSS uses ANOVA (Analysis of Varience) analysis of variance to determine whether or not there is an effect of treatment on the parameters tested, followed by the Duncan Multiple Range Test (DMRT) test if the results show significant differences with a significant level of 5%.

3. RESULTS AND DISCUSSION

3.1 Postharvest Coffee

3.1.1 Harvesting

Farmers in the Pango Pango area, Tana Toraja Regency harvest by manually picking red coffee cherries and collecting them into sacks. In a year, harvesting is carried out from February to April and from September to November. This is in accordance with the statement of Rahardjo [5], which states that the harvest time for coffee cherries is not carried out simultaneously due to differences in the age of the fruit in the same bunch. The harvesting process carried out by farmers is in accordance with SNI postharvest coffee handling, namely picking coffee berries manually on fruit that is already red in color.

3.1.2 Sorting Coffee Fruit

Sorting is done manually by braising, namely soaking the coffee cherries in a basin or container filled with water for approximately one hour. Coffee cherries that float indicate that the coffee cherries are damaged and will be separated, while coffee cherries that sink will be processed further. Farmers carry out sorting immediately after harvesting, this aims to prevent the coffee cherries from turning black. This is in accordance with the statement of Yokawati & Wachjar [2], after the harvest process, agricultural products are still undergoing metabolism, therefore the harvested products must be processed immediately. The sorting process carried out by farmers is in accordance with SNI postharvest coffee handling, namely sorting is carried out by separating good coffee fruit from dirt and inferior fruit using water.

3.1.3 Peeling Fruit Skin

Peeling fruit skin is carried out using a manual pupler machine with a semi-wash processing method, this process saves water use and does not require a long time. After peeling, the resulting wet horn skinned coffee beans are then washed using water but beforehand they are soaked for around 1-2 hours to release the mucus on the coffee beans. This is in accordance with the statement of Angriani [6], which stated that after the stripping process, immersion was carried out again to release the mucus within a certain period of time. The peeling process

carried out is in accordance with SNI postharvest coffee handling, namely peeling the skin of the fruit using a pulper, where the semiwash method will save water.

3.1.4 Drying and Storing Coffee Beans

The coffee beans are dried in the sun using tarpaulins or sacks on the ground while turning them over so that the dryness level is even, then collected in sacks and stored in the house. Drying coffee beans takes around 3 to 4 days, but if it rains, drying takes around 1 week. Coffee beans are said to be dry if they make a rustling sound when they are stirred and are not moist when held. This is in accordance with the statement of Angriani [6], which states that drying coffee beans at the farm level uses the help of the sun so it takes a long time depending on the weather. The drying process carried out by farmers is not in accordance with SNI postharvest handling of coffee beans, namely that coffee beans must be dried on a cement floor and protect the coffee beans from foreign object contamination, based on observations of farmers in the Pango-Pango area, drying them on the ground and not paying attention to dirt or foreign objects. found in coffee beans

3.1.5 Horn Skin Stripping

Horn stripping is carried out by UKM Akarosta. Before hulling the coffee beans, the water content will be calculated to a maximum of 12% using a grain moisture meter. If the water content exceeds this measurement, the coffee beans will be dried again. After carrying out the hulling process, green beans are obtained which are packaged in sacks to be stored until further processing or sold immediately. Coffee beans from the drying process are still covered with horn skin so that the horn skin is peeled using a huller to get green beans [7]. The horn skin peeling carried out by UKM Akarosta is in accordance with the SNI of postharvest handling, which is hulling is done after drying, if the horn shell coffee beans have been overnight, they must be dried again until they are dry enough.

3.2 Coffee Bean Processing

3.2.1 Roasting Coffee Beans

Before the roasting process, the water content of the green beans will first be calculated at around 9-12%, if the water content exceeds 12% then the green beans will be dried again, before roasting a sorting process will be carried out to separate the defective and non-defective green beans manually and Green beans are sifted to obtain uniformity in size. Coffee beans are roasted at different levels of maturity, namely light roast, medium roast and dark roast. Coffee beans that have uniform size make the roasting process relatively easy to control [8]. This is in accordance with the SNI postharvest handling guidelines for coffee beans, namely that before processing the coffee beans, sorting needs to be carried out to separate the coffee beans based on size, bean defects and foreign objects in order to obtain coffee bean quality requirements that comply with SNI.3.2.2 Milling and Packaging

3.2.2 Milling and Packaging

The grinding process is carried out using a grinder machine powered by a combustion engine. After the grinding process is carried out, the packaging process is carried out in a clean place, the coffee powder is packaged in P-IRT standard aluminum foil packaging in sizes 250 grams and 500 grams. Coffee products are marketed through social media and sold directly to consumers. Packaging aims to maintain the quality of the distinctive taste and aroma of ground coffee, therefore packaging is required that complies with applicable packaging standards [9].

3.3 Coffee Quality

3.3.1 Water Content

Table 1. Water Content of Green Bean

No.	Sample (*Green Bean*)	Average Water Content (%)	Water Content SNI (%)
1.	Arabica	11.67	Maks. 12.5
2.	Robusta	12.37	Maks. 12.5

Based on Table 1, the arabica sample has an average water content value of 11.67% and the robusta sample has an average water content of 12.37, this shows that both samples have met SNI No. 01-2907-2008 which is a maximum water content is 12.5%. Water content is influenced by the drying process, water content that is too high affects the durability of the coffee, high water content causes the risk of mold growth due to high humidity, which causes physical and taste changes. Likewise, if the coffee beans are too dry it can cause permanent damage to the coffee beans, coffee beans that are too dry become very brittle and break easily. In order to reduce the water content of a material, a drying process is carried out. Water content has an important role in determining the quality and storability or durability of coffee beans [10].

Table 2. Water Content of Ground Coffee

Treatment	Water Content of Arabica Ground Coffee (%)	Water Content of Robusta Ground Coffee (%)	Water Content of Ground Coffee SNI No. 01-3542-2004 (%)
Light Roast	1.042	1.060	
Medium Roast	1.032	1.054	Maks. 7
Dark Roast	1.014	1.038	

Table 2 shows the average water content value of ground coffee that meets the SNI No. 01-3542-2004 which is water content of ground coffee is maximum of 7%. The highest water content value of arabica coffee in the light roast treatment is 1.042% and the lowest water content value was in the dark roast treatment is 1.014. Likewise for robusta coffee, the highest average water content was in the light roast treatment is 1.060% and the lowest average water content was in the dark roast treatment is 1.038%. Water content affects the durability of the material, the lower the water content, the longer the absorption of water vapor from the air. The water content of arabica ground coffee is lower than the water content of robusta ground coffee, this is influenced by the drying process of the coffee beans and the initial water content of the coffee beans before roasting. The water content of ground coffee tends to decrease with increasing roasting temperature.The higher the roasting temperature, the lower the water content in coffee beans [11].

Based on result, the p-value for arabica ground coffee is 0.0001, where the p-value is <0.05 (5%), so it is continued with Duncan's further test and it is known that the roasting temperature treatment on arabica coffee beans shows that real interaction with the value of water content of ground coffee. Meanwhile, the p-value for robusta ground coffee is 0.057, where the number p-value>0.05 (5%) indicates that the roasting temperature treatment has no significant effect on the water content value of robusta ground coffee

3.3.2 Size of Green Bean

Table 3. Green Beans Percentage is Restrained

Types of Coffee	Sieve Diameter (mm)	Green Beans Percentage is Restrained (%)
	6.5	22.53
Arabica	6	52.81
	5	24.66
	7.5	5.24
Robusta	6.5	31.46
	5.5	63.31

Based on the results, the size of the arabica beans in UKM Akarosta is classified as medium, where the largest percentage is on the sieve 6.5 mm, while for robusta coffee beans it is classified as small, which is the percentage of green beans retained is the highest on the sieve 5.5 mm. The grouping of green beans based on size was carried out by UKM Akarosta in accordance with the requirements for grouping coffee bean sizes of SNI No. 01-2907-2008, the grouping of coffee bean sizes aims to make coffee maturity more even and increase sales value to consumers. The uniformity in bean size makes roasting easier to control and the coffee matures evenly [12].

3.3.3 Color

Table 4. *L Value (Brightness Level) of Coffee Beans

Sample	Average *L Value
Arabica *Light*	12.78
Arabica *Medium*	8.35
Arabica *Dark*	5.23
Robusta *Light*	27.60
Robusta *Medium*	9.98
Robusta *Dark*	6.97

The L* value indicates the brightness level ranging from 0 (black) to 100 (white). Based on table 4, the L* value for arabica coffee beans ranges from 5.23 to 12.78 and for robusta coffee beans the L* value ranges from 6.97 to 27.60. A low L* value close to 0 indicates that the color of the coffee beans tends to be dark. This is in accordance with the statement of [13], which states that the L* value indicates the brightness of a sample, the higher the temperature and longer the roasting time, the closer the color of the coffee beans to dark brown black.

Based on result, a p-value of 0.000 was obtained based on the DMRT test where the p-value<0.05 (5%), so it was continued with Duncan's further test where it was found that the roasting temperature treatment on arabica coffee beans and robusta coffee beans showed there is a real interaction with the *L value of coffee.

Table 5. *a Value of Coffee Beans

Sample	Average a* Value
Arabica *Light*	2.65
Arabica *Medium*	1.56
Arabica *Dark*	0.38
Robusta *Light*	9.24
Robusta *Medium*	3.27
Robusta *Dark*	2.97

Positive a* value (0 to 100) indicates red and a negative a* value (0 to -80) indicates green. Based on Table 5, the average a* value for arabica coffee beans ranges from 0.38 to 2.65 and robusta coffee beans ranges from 2.97 to 9.24. . The low a* value indicates that coffee beans change color into dark brown due to the Maillard reaction [13]. Dark roasted coffee beans showed the lowest a* value since the color is the darkest among other roasting level.

Based on result, a p-value of 0.000 was obtained based on the DMRT test where the p-value <0.05 (5%), so it was continued with Duncan's further test where it was found that the roasting temperature treatment showed a real interaction with the *a value of coffee.

Table 6. b* Value of Coffe Beans

Sample	Average b* Value
Arabica *Light*	10.98
Arabica *Medium*	10.12
Arabica *Dark*	9.53
Robusta *Light*	14.40
Robusta *Medium*	9.41
Robusta *Dark*	8.69

The b* value of 0-70 indicates yellow and b* value of -70 to 0 indicates blue. Based on Table 6, the highest of average b* value for arabica coffee beans in the light roast treatment is 10.98 and the lowest b* value in the dark roast treatment is 9.53. The highest b* value for robusta coffee was in the light roast treatment is 14.40 and the lowest b* value was in the dark roast treatment is 8.69.

Based on result, a p-value of 0.010 was obtained based on the DMRT test where the p-value<0.05 (5%), so it was continued with Duncan's further test where it was found that the roasting temperature treatment on arabica coffee beans and robusta coffee beans showed there is a real interaction with the *b value of coffee.

Table 7. Chroma Value and Total Color Change

Sampel	Chroma	Total Color Change (ΔE)
Arabica *Light*	11.50	4.87
Arabica *Medium*	10.25	3.92
Arabica *Dark*	9.53	3.21
Robusta *Light*	17.13	6.42
Robusta *Medium*	9.99	6.07
Robusta *Dark*	9.27	3.36

Table 7 are shows the highest chroma value for arabica coffee beans in the light roast treatment is 11.5 and for robusta coffee beans, the highest chroma value in the light roast treatment is 17.13. The chroma value indicates the strength or weakness of the color, a high chroma value indicates that the temperature treatment of the sample produces an intense color, roasting affects the color of the coffee beans, the higher the temperature, the darker the color of the coffee beans. The color obtained is blackish brown which is classified as normal in accordance with the coffee quality requirements of SNI No. 01-3542-2004. Roasting affects the color of the coffee beans, the brown color appears because the coffee is heat treated, causing the Maillard reaction to appear [4].

Based on table, it can be seen that the total color change of the samples in each treatment has a different value. The total value of color change in coffee beans gets lower as the level of coffee roasting increases, namely from light, medium and dark, where the resulting color becomes darker. Color changes in coffee beans occur due to non-enzymatic browning and pyrolysis reactions [4].

3.3.4 PH

Table 8. Average PH of Coffee Brewing

Treatment	pH of Brewed Arabica Coffee	pH of Brewed Robusta Coffee
Light Roast	5.04	5.45
Medium Roast	5.05	5.63
Dark Roast	5.47	5.78

Table 8 shows the pH values obtained at UKM Akarosta, Tana Toraja Regency. The coffee acidity standard cannot be lower than 4, this shows that the pH value obtained at UKM Akarosta meets the pH acidity standard [1]. The highest pH value for arabica coffee was in the dark roast treatment is 5.47%, as well as for Robusta coffee the highest pH value was in the dark roast treatment is 5.78. The pH value plays a role in influencing the taste of coffee. The pH value of robusta coffee brews is higher than arabica coffee brews, this is because robusta coffee has a higher acid (chlorogenic) content. The roasting temperature causes the pH value to increase, the higher the temperature, the higher the pH value. The higher the roasting temperature will cause damage to the acids in coffee so that the pH of the coffee will increase [11].

Based on result, the pH value with the data analysis that has been carried out obtains a p-value of 0.000 where the p-value<0.05 (5%), so it is continued with Duncan's further test where it is known that the roasting temperature treatment on arabica coffee and robusta coffee shows a real interaction with the pH value of coffee brewing.

3.3.5 Ash Content

Tabel 8. Average Ash Content of Coffee.

Treatment	Ash Content of Arabica Coffee (%)	Ash Content of Robusta Coffee (%)	Ash Content SNI No. 01-3542-2004 (%)
Light Roast	3.73	3.41	
Medium Roast	3.76	3.48	Maks. 5
Dark Roast	3.77	3.54	

Table 9 shows the average value of coffee ash content in Akarosta UKM, Tana Toraja Regency which has met the quality standard for ash content in SNI No. 01-3542 2004 is maximum 5%. The highest ash content value for arabica coffee was in the dark roast treatment is 3.77%, while the lowest ash content value was in the light roast treatment is 3.73%. The highest ash content for robusta coffee was in the dark roast treatment is 3.54, and the lowest ash content was in the light roast treatment is 3.41%. In the table it can be seen that the higher the roasting temperature, the higher the ash content value. This is in accordance with the statement of [4], which states that the temperature during roasting affects the ash content produced, increasing the temperature causes a lot of water to evaporate from the ingredients so that more minerals are left behind.

Based on result, the p-value obtained based on the DMRT test for arabica coffee was 0.937 and for robusta coffee 0.965, where the p-value>0.05 (5%) indicating that roasting temperature had no real effect on the ash content value.

4. CONCLUSION

Based on the research of Postharvest Handling and Processing of Coffee Bean in UKM Akarosta, Tana Toraja Regency, it can be concluded that:

1. The postharvest process is carried out by farmers in Pasang, South of Makale District. Tana Toraja Regency using the semiwash method which includes harvesting, sorting, pulping, washing, drying, hulling, sorting, roasting, milling and packaging by UKM Akarosta.

2. The postharvest process carried out by farmers has met SNI standards for correct postharvest handling of coffee beans, however, due to limited equipment and drying handling facilities, it is not fully appropriate, but this does not affect the quality.
3. The quality of the coffee beans produced starting from water content, ash content, color, pH and size of green bean at UKM Akarosta has met the SNI standards for coffee bean quality No. 01-2907-2008 and SNI quality of ground coffee No. 01-3542-2004.

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