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Analysis of Arabica Coffee Characteristics and Drying Method on Arabica Coffee Flavor Using Analysis of Variance

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ABSTRACT

Purpose: This study investigated the effect of the coffee drying process using a coffee drying house on the moisture content, acidity, caffeine value, and flavor of arabica coffee.

Design/methodology/approach: An experimental method with a two-factor analysis of variance was used to evaluate significant differences between three different drying processes: Before Drying Process, Sun Drying Process, and Drying Process with Coffee Drying House

Findings: The results showed that sun-drying coffee with a coffee drying house produced coffee with lower moisture content, acidity, and caffeine value compared to the other drying processes

Research limitations/implications: The research location was Karot Village, Langke Rembong Subdistrict, Manggarai Regency. The object of research was the drying process of arabica coffee beans and the measurement of moisture content, acidity content and caffeine content of arabica coffee. The method used was analysis of variance with a fixed model (one-way anava design, block subsampling anava and two-factor anava). The data obtained were the acidity value, caffeine value, moisture content and coffee flavour.

Practical implications: The results of the research were successful and improved the quality of coffee exports in Karot Village, Langke Rembong District, Manggarai Regency.

Originality/value: The research carried out by the researcher states that this research is the result of his work and is the first time at Karot Village, Langke Rembong District, Manggarai Regency with the title of the research being researched, except for quotations from several summaries, all of which the researcher has explained the source.

Paper type: Research Paper

Keyword: *Anova Block Subsampling, Anova 1 Factor Fixed Model, Anova 2 Factor Factorial Design, Arabica Coffee Characteristics, Drying Process, Arabica Coffee Flavors*

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I. INTRODUCTION

Coffee is one of the most popular beverages around the world today. Moisture content, acidity value and caffeine value are obtained from coffee (Hendrasto F, 2017). Young adults in their productive years are the main consumers of coffee. The acidity value and caffeine value as well as the moisture content in coffee can be used to assess the quality of a cup of coffee (Pradipta & Fibrianto, 2017). The three elements that affect coffee quality are acidity, caffeine and moisture content. The sour taste of coffee is caused by acidity, in addition to caffeine and moisture content is one of the ingredients that give coffee a bitter taste (Blumberg et al., 2010). Consuming coffee can relieve sleepiness and fatigue. On the other hand, excessive caffeine intake can also have a negative impact on health, for example affecting behavior and cardiovascular problems and calcium absorption (Pradipta & Fibrianto, 2017). Coffee contains acids, both volatile and non-volatile, which contribute to its acidity in addition to caffeine. These acids help give coffee its flavor (Sunarharum et al., 2014). The caffeine content, acidity value and moisture content in good coffee should not be too high or low. Consumption of coffee with high caffeine,

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acidity and low water content can cause digestive problems, especially the release of stomach acid (Pradipta & Fibrianto., 2017). Consuming caffeine has two negative effects. Caffeine has adverse effects on the nervous system, circulatory system, and can be addictive (Wikoff et al., 2017). However, coffee also has the advantage of supporting metabolism, being a source of antioxidants, and having other effects (Pradipta & Fibrianto, 2017). There is approximately 102-200 mg of caffeine in a cup of brewed coffee (± 250 ml) with a standard percentage of 1-3% (CSPI, 2023). Coffee has a pH between 4 - 6%, therefore if it is too acidic, it can cause damage to the coffee. In addition, the moisture content of coffee that is suitable for coffee quality ranges from 10-12.5%. If the moisture content of coffee is above 12.5%, it can cause the coffee flavor to become bland and the resulting coffee beans to be damaged because they have been contaminated by bacteria (CSPI, 2023).

One of the things that must be considered in order to produce quality coffee with a sweet coffee flavor is the drying process of coffee beans. Drying of coffee beans has the main purpose as a process to remove the water content in the coffee beans and can increase the acidity degree value and reduce the caffeine value so that the coffee beans will avoid the potential for quality deterioration in the final processing process, namely storage in the warehouse. The deterioration or damage (deteoration) in question is initiated by the presence of high water in the beans, for example causing mold or triggering the presence of warehouse pests. Some fungal species can also produce certain chemical compounds that are toxic to humans, such as the ochratoxin compound caused by Aspergillus ocracheus. In addition to causing toxicity in coffee, fungal attack can also reduce the potential for flavor to be produced, so aspects of drying techniques are important to consider (CSPI, 2023).

The people of Indonesia, especially in Karot Village, Langke Rembong Sub-district, Manggarai Regency, still dry coffee traditionally or directly under the sun with a tarpaulin in front of the house. This method is quite effective in accelerating the drying process of coffee beans, but when the weather is rainy, the coffee beans that are temporarily dried will be lifted and stored inside the house. In addition, because they are dried outside in the open air, the coffee beans will be exposed to dust and bacteria. And also, every 2-3 hours the coffee beans that are temporarily dried must be checked periodically by flipping the coffee beans so that the drying process of the coffee beans can be evenly distributed. That is what can cause the high water content, acidity and caffeine levels in the coffee beans. In addition to the traditional drying process directly under the sun, the process before drying is also important. This process is done in order to know the initial process of the condition of the coffee beans when they have just been picked from the tree. In addition, when the coffee cherries are still wet and the ones that have been picked will be sorted to separate the ripe and immature coffee cherries. Ripe coffee fruit is full red in color, while immature coffee fruit is pale whitish and slightly wrinkled. The ripe coffee fruit will be washed with clean water to remove dirt and fruit residue. After washing, the coffee fruit will be put into sacks to store the coffee fruit. After being stored for a long time, the coffee fruit will be washed again to remove any remaining dirt. The clean coffee fruit will be peeled off the skin using a huller machine to produce arabica coffee beans. Arabica coffee beans will then be dried in the sun until the moisture content reaches 10-12%.

Apart from using sun drying, coffee drying can also be done using the coffee drying house drying method. The drying method with a coffee drying house can dry coffee evenly and in a shorter time. In addition, the drying process with a coffee drying house can be done indoors, so that the coffee beans are better protected from contamination. The drying house method is carried out by drying coffee beans without horn skins that are still wet and the thickness of the beans is low so that the heat transfer rate is obtained in the process of drying the beans more evenly and evaporating water directly from the beans so that saturation does not occur which causes the beans to require higher heat (excess) to evaporate water. Sufficient and not excessive heat energy during drying will maintain unnecessary evaporation of volatile aroma-forming compounds, so that the potential aroma of coffee will be better and have a stronger flavor potential (bold). In addition, it is also necessary to analyze the effect of moisture content, acidity value and caffeine value on the flavor of arabica coffee in the drying process to improve the quality of arabica coffee.

Therefore, this research will use the experimental method with analysis of variance using Anova Block Subsampling, Anova 1 Factor Fixed Model and Anova 2 Factor Factorial Design. An experimental method using two-factor analysis of variance is a statistical approach to analyze significant differences between two or more groups of data. In a research context, the rationale for using this method can be based on the need to understand the effect of multiple independent variables on a dependent variable. For example, a study on the effect of moisture content, acidity, and caffeine content on coffee flavor uses one-factor ANOVA and subsampling block ANOVA to determine whether variations in these three variables during the coffee drying process have a significant effect on coffee flavor.

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II. METHODS

The research was conducted in Karot Village, Langke Rembong Sub-district, Manggarai Regency. The research conducted was quantitative research. The methods used by researchers are the fixed model variance analysis method, subsampling block variance analysis and factorial design variance analysis.

In the context of this research, it involves coffee farmers in Karot village and the type of coffee studied is arabica coffee. Arabica coffee flavor served as the sole dependent variable in this quasi-experimental study, while moisture content and drying process served as the two independent variables. The researcher applied three different drying processes, namely:

1. Pre-Drying Process
2. Sun-drying Process
3. Drying process with a coffee drying house.

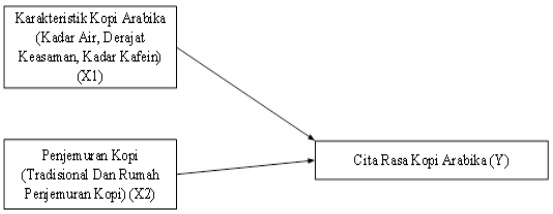

Figure 1. Framework Of Thought

The research hypotheses in this study are:

H01: There is no effect of arabica coffee characteristics on the taste of arabica coffee

H11: There is an influence of arabica coffee characteristics on the taste of arabica coffee

H02: There is no effect of arabica coffee characteristics on the drying process

H12: There is an effect of arabica coffee characteristics on the drying process

H03: There is no effect of arabica coffee characteristics and arabica coffee drying process on the taste of arabica coffee.

H13: There is an effect of Arabica coffee characteristics and the drying process of Arabica coffee on the taste of Arabica coffee.

III. RESULTS AND DISCUSSION

1. Fixed Model Analysis of Variance Before Drying

Table 1 Fixed Model Analysis of Variance With One Way Annova Before Drying

	Characteristics of Arabica Coffee			*Total*
	Moisture Content (%)	*Accidity (PH)*	*Caffeine Levels (%)*	
Taste (1,2,3)	*33.5*	*12.17*	*11.15*	
	30	*13.25*	*12.85*	
	27.4	*12.6*	*12.01*	
	21	*14*	*11.21*	
	26.7	*13.05*	*12.93*	
	22.9	*12.22*	*12.07*	

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	34.8	*13.4*	*11.27*	
	23.4	*13.8*	*12.99*	
	25	*12.71*	*12.13*	
	32.2	*12.5*	*11.33*	
	34.5	*13.64*	*13.05*	
	27.1	*14*	*12.19*	
	30.3	*12.9*	*11.39*	
	40.2	*12.4*	*13.11*	
	24.8	*13.25*	*12.25*	
	23.7	*13.74*	*11.45*	
	41.4	*12.02*	*13.17*	
	33.7	*12.19*	*12.31*	
	44.4	*12.17*	*11.51*	
	30.6	*13.25*	*13.23*	
	33.5	*12.6*	*12.37*	
	30	*14*	*11.57*	
	27.4	*13.05*	*13.29*	
	21	*12.22*	*12.43*	
Total	*719.5*	*311.13*	*293.26*	*1323.89*
Many Observations	*24*	*24*	*24*	*72*
Average	*29.97916667*	*12.96375*	*12.21916667*	*18.38736111*

For the research hypothesis:
H0 : There is no effect of arabica coffee characteristics on the taste of arabica coffee
H1 : There is an influence of arabica coffee characteristics on the taste of arabica coffee

$$R_y = \frac{(1323.89)^2}{72} = 24342.84$$

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$$W_y = P_y = \frac{719.5^2}{24} + \frac{311.13^2}{24} + \frac{293.26^2}{24} - 24342.84 = 4843.971$$

$$\sum Y^2 = 30117.87$$

$$E_y = 30117.87 - 4843.971 - 24342.84 = 931.0545$$

Table 2 Anova For Data Before Drying

Source Of Variation	*dk*	*JK*	*RJK*	*ERJK*	F_{Count}	F_{Table}
Average	*1*	*24342,84*	*24342,84*	-		
Characteristics of Arabica Coffee	*2*	*4,843,971*	*2,421,986*	$\sigma_\epsilon^2 + \emptyset(M)^{*)}$	*5,462,806*	*3,47*
Fallacy	*21*	*9,310,545*	*4,433,593*	σ_ϵ^2		
Total	*24*	*30117,87*	-	-	-	

The conclusion is FCount > FTable, which means that there is a very significant effect of arabica coffee characteristics on the taste of arabica coffee.

Mean Test After Anava with Newman-Keuls Test

Mean	: 29,97916667; 12,96375; 12,21916667	
Treatment	: 1 2 3	
RJK (Fallacy)	: 3,47	
dk	: 21	
dk=21 dan α	=0.05	
P	= 2 3	
Range	= 3.00 3.65	
P	= 2 3	
RST	=4.08 4.964	
2 opponent 3	->	0.745 < 4.964
1 opponent 3	->	17.76 > 4.964
2 opponent 1	->	-17.02 < 4.08

Conclusion:

1) $F_{Count} < F_{Table}$, so there is no difference between treatments 2 and 3 (acidity and caffeine content) on the taste of arabica coffee.
2) $F_{Count} > F_{Table}$ then there is a difference between treatments 1 and 3 (moisture content and caffeine content) on the taste of arabica coffee.
3) $F_{Count} < F_{Table}$ then there is no difference between treatments 2 and 1 (acidity and moisture content) on the taste of arabica coffee.

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2. Fixed Model Analysis of Variance for Sun Drying

Table 3 Fixed Model Analysis of Variance With One Way Annova Sun Drying

	Characteristics of Arabica Coffee			
	Moisture Content (%)	*Accidity Level (PH)*	*Caffeine Content (%)*	*Total*
Taste (1,2,3)	*13.2*	*8.17*	*4.56*	
	14.1	*8.46*	*3.65*	
	12.8	*7.6*	*4.75*	
	15.3	*7.87*	*4.7*	
	13.7	*8.05*	*4.63*	
	12.9	*8.32*	*4.37*	
	14.8	*8.38*	*4.24*	
	13.4	*8.66*	*4.05*	
	15	*8.83*	*3.9*	
	12.6	*8.5*	*3.35*	
	14.5	*8.78*	*3.95*	
	13.1	*8.95*	*3.75*	
	15.2	*8.62*	*4.13*	
	12.7	*8.89*	*3.8*	
	14.6	*9.06*	*3.55*	
	13	*8.74*	*4.01*	
	15.1	*9.02*	*3.6*	
	13.5	*9.19*	*3.45*	
	14.4	*8.86*	*3.85*	
	13.3	*9.14*	*3.5*	

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	14.9	*9.31*	*3.3*	
	13.5	*8.98*	*3.7*	
	15.4	*9.26*	*3.4*	
	12.6	*9.43*	*3.25*	
Total	*333.6*	*209.07*	*93.44*	*636.11*
Many Observations	*24*	*24*	*24*	*72*
Average	*13.9*	*8.71125*	*3.893333333*	*8.834861111*

For the research hypothesis:
H0: There is no effect of arabica coffee characteristics on the taste of arabica coffee
H1: There is an influence of arabica coffee characteristics on the taste of arabica coffee

$$R_y = \frac{636.11^2}{72} = 5619.94$$

$$W_y = P_y = \frac{333.6^2}{24} + \frac{209.07^2}{24} + \frac{93.44^2}{24} - 5619.94 = 1202.151$$

$$\sum Y^2 = 6853.402$$

$$E_y = 6853.402 - 1202.151 - 5619.94 = 31.307$$

Table 4 Anova For Sun Drying Data

Source Of Variation	*Dk*	*JK*	*RJK*	*ERJK*	F_{Count}	F_{Table}
Average	*1*	*5619,94*	*5619,94*	-		
Characteristics of Arabica Coffee	*2*	*1,202,151*	*601,075*	$\sigma_\epsilon^2 + \emptyset(M)^t$	*403,406*	*3,47*
Fallacy	*21*	*31,307*	*1,49*	σ_ϵ^2		
Total	*24*	*6,853,402*	-	-	-	

The conclusion is FCount > FTable, which means that there is a very significant effect of arabica coffee characteristics on the taste of arabica coffee.

Mean Test After Anava with Newman-Keuls Test
Means : 13,9; 8,71; 3,89

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Treatment	: 1	2	3
RJK (Fallacy)	: 3,47		
dk	: 21		
dk=21 dan α	=0.05		
P	= 2	3	
Range	=3.00	3.65	
P	= 2	3	
RST	=0.75	0.91	
2 opponent 3	->	4.82 > 0.91	
1 opponent 3	->	10.01 > 0.91	
1 opponent 2	->	5.19 > 0.75	

Conclusion:

1) $F_{Count} > F_{Table}$ then there is a difference between treatments 2 and 3 (acidity and caffeine content) on the taste of arabica coffee.
2) $F_{Count} > F_{Table}$, there is a difference between treatments 1 and 3 (moisture content and caffeine content) on the taste of Arabica coffee.
3) $F_{Count} > F_{Table}$, there is a difference between treatments 1 and 2 (moisture content and acidity) on the taste of arabica coffee.

3. Fixed Model Analysis of Variance with Coffee Drying House

Table 5 Fixed Model Analysis Of Variance With One Way Anova With Coffee Drying House

	Characteristics of Arabica Coffee			
	Moisture Content (%)	*Acidity Level (PH)*	*Caffeine Content (%)*	*Total*
Taste (1,2,3)	*9.66*	*3.46*	*1.71*	
	9.14	*3.09*	*1.65*	
	9.2	*3.15*	*1.6*	
	10.23	*4.9*	*1.55*	
	9.32	*3.27*	*1.86*	
	8.79	*2.65*	*2.25*	
	9.85	*3.67*	*1.95*	
	10.15	*4.82*	*1.35*	
	9.7	*3.5*	*1.79*	
	9.28	*3.2*	*1.63*	
	8.39	*2.42*	*2.53*	
	10.68	*5.25*	*1.15*	

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	12.29	*6.45*	*1.1*	
	12.26	*6.4*	*1.05*	
	12.29	*6.45*	*1*	
	9.72	*3.55*	*1.84*	
	9.22	*3.17*	*1.65*	
	8.56	*2.56*	*2.4*	
	11.22	*5.7*	*0.8*	
	10.15	*4.82*	*0.75*	
	9.7	*3.5*	*1.79*	
	9.28	*3.2*	*1.63*	
	8.39	*2.42*	*2.53*	
	10.68	*5.25*	*1.15*	
Total	*238.15*	*96.85*	*38.71*	*373.71*
Many Observation	*24*	*24*	*24*	*72*
Average	*9.922916667*	*4.035416667*	*1.612916667*	*5.190416667*

For the research hypothesis:
H0: There is no effect of arabica coffee characteristics on the taste of arabica coffee
H1: There is an influence of arabica coffee characteristics on the taste of arabica coffee

$$R_y = \frac{373.71^2}{72} = 1939.71$$

$$W_y = P_y = \frac{238.15^2}{24} + \frac{96.85^2}{24} + \frac{38.71^2}{24} - 1939.71 = 876.698$$

$$\sum Y^2 = 2892.8$$

$$E_y = 2892.8 - 876.698 - 1939.71 = 76.39$$

Table 6 Anova For Coffee Drying House Data

Source Of Variations	*dk*	*JK*	*RJK*	*ERJK*	F_{Count}	F_{Table}
Average	*1*	*1939,71*	*1939,71*	*-*	*11,48*	*3,47*

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Characteristics of Arabica Coffee	*2*	*876,698*	*438,349*	$\sigma_\epsilon^2 + \emptyset(M)^{(1)}$	
Fallacy	*21*	*76,39*	*3,64*	σ_ϵ^2	
Total	*24*	*2892,8*	-	-	-

The conclusion is $F_{Count} > F_{Table}$, which means that there is a significant effect of arabica coffee characteristics on the taste of arabica coffee.

Mean Test After Anava with Newman-Keuls Test

Mean	: 9,92; 4,04; 1,61		
Treatment	: 1	2	3
RJK (Fallacy)	: 3,47		
dk	: 21		
dk=21 dan α	=0.05		
P	= 2	3	
Range	=3.00	3.65	
P	= 2	3	
RST	=1.26	1.53	
2 opponent 3	->	2.43 > 1.53	
1 opponent 3	->	8.31 > 1.53	
1 opponent 2	->	5.88 > 1.26	

Conclusion:

1) $F_{Count} > F_{Table}$ then there is a difference between treatments 2 and 3 (acidity and caffeine content) on the taste of arabica coffee.
2) $F_{Count} > F_{Table}$, there is a difference between treatments 1 and 3 (moisture content and caffeine content) on the taste of Arabica coffee.
3) $F_{Count} > F_{Table}$, there is a difference between treatments 1 and 2 (moisture content and acidity) on the taste of arabica coffee.

4. Anova with Block Design Subsampling of Moisture Content with Drying

Table 7 Anova With Block Subsampling Design (Moisture Content And Drying Process)

Block		*Treatment*				
		Before Drying	*Sun Drying*	*Coffee Drying House*	*Total*	*Average*
Moisture Content (%)	*1*	*33.5*	*13.2*	*9.66*		
	2	*30*	*14.1*	*9.14*		
	3	*27.4*	*12.8*	*9.2*		

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4	*21*	*15.3*	*10.23*		
5	*26.7*	*13.7*	*9.32*		
6	*22.9*	*12.9*	*8.79*		
J1j	*161.5*	*82*	*56.34*	*299.84*	*16.65778*
1	*34.8*	*14.8*	*9.85*		
2	*23.4*	*13.4*	*10.15*		
3	*25*	*15*	*9.7*		
4	*32.2*	*12.6*	*9.28*		
5	*34.5*	*14.5*	*8.39*		
6	*27.1*	*13.1*	*10.68*		
J2j	*177*	*83.4*	*58.05*	*318.45*	*17.69167*
1	*30.3*	*15.2*	*12.29*		
2	*40.2*	*12.7*	*12.26*		
3	*24.8*	*14.6*	*12.29*		
4	*23.7*	*13*	*9.72*		
5	*41.4*	*15.1*	*9.22*		
6	*33.7*	*13.5*	*8.56*		
J3j	*194.1*	*84.1*	*64.34*	*342.54*	*19.03*
1	*44.4*	*14.4*	*11.22*		
2	*30.6*	*13.3*	*10.15*		
3	*33.5*	*14.9*	*9.7*		
4	*30*	*13.5*	*9.28*		
5	*27.4*	*15.4*	*8.39*		

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6	*21*	*12.6*	*10.68*		
J4j	*186.9*	*84.1*	*59.42*	*330.42*	*18.35667*
Big Quantity	*719.5*	*333.6*	*238.15*	*1291.25*	
Average	*9.993055556*	*4.633333333*	*3.307638889*		*0.249084*

Research Hypothesis:
H0= No Effect of Arabica Coffee Moisture Content on the Drying Process
H1= There is an Effect of Arabica Coffee Moisture Content on the Drying Process

$$\sum Y^2 = 29530.84$$

$$R_y = \frac{(1291.25)^2}{(3)(6)(4)} = 23157.31$$

$$S_b = \frac{(161.5)^2 + (82)^2 + (56.34)^2 + \cdots \ldots\ldots + (186.9)^2 + (84.1)^2 + (59.42)^2}{3x6} - 23157.31 = 19857$$

$$S_y = 29530.84 - 23157.31 - 19857 = -13483.5$$

$$B_y = \frac{(299.84)^2 + (318.45)^2 + (342.54)^2 + (330.42)^2}{3x6} = 23212.53$$

$$P_y = \frac{(719.5)^2 + (333.6)^2 + (238.15)^2}{4X6} - 23157.31 = 5412.883$$

$$E_y = 19857 - 23212.53 - 5412.883 = -8768.41$$

Table 8 Anova Block Design Of Moisture Content And Drying Process

Source Of Variations	*Dk*	*JK*	*RJK*	F_{Count}	F_{Table}
Average	*1*	*23157.31*	*23157.31*		
Block	*3*	*23212.53*	*7737.51*		
Drying	*2*	*5412.883*	*2706.442*	*-1.85*	*3.15*
Experiment Error	*6*	*-8768.41*	*-1461.4*		
Sampling Error	*60*	*-13483.5*	*-224.725*		
Total	*72*	*29530.84*			

$F_{Count} < F_{table}$ then H0 accepted H1 rejected. There is no significant effect of arabica coffee moisture content on the drying process.

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5. Anova with Block Design Subsampling of Acidity Level with Drying

Table 9 Anova With Block Subsampling Design (Acidity Level And Drying Process)

Block		Treatment				
		Before Drying	Sun Drying	Coffee Drying House	Total	Average
Acidity Content (PH)	1	12.17	8.17	3.46		
	2	13.25	8.46	3.09		
	3	12.6	7.6	3.15		
	4	14	7.87	4.9		
	5	13.05	8.05	3.27		
	6	12.22	8.32	2.65		
	J1j	77.29	48.47	20.52	146.28	8.126667
	1	13.4	8.38	3.67		
	2	13.8	8.66	4.82		
	3	12.71	8.83	3.5		
	4	12.5	8.5	3.2		
	5	13.64	8.78	2.42		
	6	14	8.95	5.25		
	J2j	80.05	52.1	22.86	155.01	8.611667
	1	12.9	8.62	6.45		
	2	12.4	8.89	6.4		
	3	13.25	9.06	6.45		
	4	13.74	8.74	3.55		
	5	12.02	9.02	3.17		
	6	12.19	9.19	2.56		

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J3j	*76.5*	*53.52*	*28.58*	*158.6*	*8.811111*
1	*12.17*	*8.86*	*5.7*		
2	*13.25*	*9.14*	*4.82*		
3	*12.6*	*9.31*	*3.5*		
4	*14*	*8.98*	*3.2*		
5	*13.05*	*9.26*	*2.42*		
6	*12.22*	*9.43*	*5.25*		
J4j	*77.29*	*54.98*	*24.89*	*157.16*	*8.731111*
Big Quantity	*311.13*	*209.07*	*96.85*	*617.05*	
Average	*4.32125*	*2.90375*	*1.345138889*		*0.11903*

Research Hypothesis:
H0 = No Effect of Arabica Coffee Acidity Level on the Drying Process
H1 = There is an Effect of Arabica Coffee Acidity Level on the Drying Process

$$\sum Y^2 = 6300.669$$

$$R_y = \frac{(617.05)^2}{(3)(6)(4)} = 5288.204$$

$$S_b = \frac{(77.29)^2 + (48.47)^2 + (20.52)^2 + \cdots \ldots \ldots \ldots + (77.29)^2 + (54.98)^2 + (24.89)^2}{3x6} - 5288.204$$

$$= 37538.66$$

$$S_y = 6300.669 - 5288.204 - 37538.66 = -36256.2$$

$$B_y = \frac{(146.28)^2 + (155.01)^2 + (158.6)^2 + (157.16)^2}{3x6} - 5288.204 = 5.08$$

$$P_y = \frac{(311.13)^2 + (209.07)^2 + (96.85)^2}{4X6} - 5288.204 = 957.30$$

$$E_y = 37538.66 - 5.08 - 957.30 = 36576.2809$$

Table 10 Anova Block Design Of Acidity Level And Drying Process

Source Of Variations	*Dk*	*JK*	*RJK*	F_{Count}	F_{Table}
Average	*1*	*5288.204*	*5288.204*		
Block	*3*	*5.08*	*1.69*		
				-10.09	*3.15*
Drying	*2*	*957.3*	*478.65*		
Experiment Error	*6*	*36576.2809*	*6096.05*		

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Sampling Error	*60*	*-36256.2*	*-604.27*	
Total	*72*	*6300.669*		

$F_{Count} < F_{table}$ then H0 accepted H1 rejected. There is no significant effect of arabica coffee acidity on the drying process.

6. Anova with Block Design Subsampling of Caffeine Content with Drying

Tabel 11 Anova With Block Subsampling Design (Caffeine Content And Drying Process)

		Treatment				
Block		*Before Drying*	*Sun Drying*	*Coffee Drying House*	*Total*	*Average*
	1	*11.15*	*4.56*	*1.71*		
	2	*12.85*	*3.65*	*1.65*		
	3	*12.01*	*4.75*	*1.6*		
	4	*11.21*	*4.7*	*1.55*		
	5	*12.93*	*4.63*	*1.86*		
	6	*12.07*	*4.37*	*2.25*		
	J1j	*72.22*	*26.66*	*10.62*	*109.5*	*6.083333*
	1	*11.27*	*4.24*	*1.95*		
Caffeine Content (%)	*2*	*12.99*	*4.05*	*1.35*		
	3	*12.13*	*3.9*	*1.79*		
	4	*11.33*	*3.35*	*1.63*		
	5	*13.05*	*3.95*	*2.53*		
	6	*12.19*	*3.75*	*1.15*		
	J2j	*72.96*	*23.24*	*10.4*	*106.6*	*5.922222*
	1	*11.39*	*4.13*	*1.1*		
	2	*13.11*	*3.8*	*1.05*		
	3	*12.25*	*3.55*	*1*		

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4	*11.45*	*4.01*	*1.84*		
5	*13.17*	*3.6*	*1.65*		
6	*12.31*	*3.45*	*2.4*		
J3j	*73.68*	*22.54*	*9.04*	*105.26*	*5.847778*
1	*11.51*	*3.85*	*0.8*		
2	*13.23*	*3.5*	*0.75*		
3	*12.37*	*3.3*	*1.79*		
4	*11.57*	*3.7*	*1.63*		
5	*13.29*	*3.4*	*2.53*		
6	*12.43*	*3.25*	*1.15*		
J4j	*74.4*	*21*	*8.65*	*104.05*	*5.780556*
Big Quantity	*293.26*	*93.44*	*38.71*	*425.41*	
Average	*4.073055556*	*1.297777778*	*0.537638889*		*0.082062*

Research Hypothesis:
H0 = No Effect of Arabica Coffee Caffeine Content on the Drying Process
H1 = There is an effect of caffeine content of Arabica coffee on the drying process

$$\sum Y^2 = 6300.669$$

$$R_y = \frac{(617.05)^2}{(3)(6)(4)} = 5288.204$$

$$S_b = \frac{(72.22)^2 + (26.66)^2 + (10.62)^2 + \cdots \ldots + (74.4)^2 + (21)^2 + (8.65)^2}{3x6} - 5288.204 = 3506.573$$

$$S_y = 6300.669 - 5288.204 - 37538.66 = -36256.2$$

$$B_y = \frac{(146.28)^2 + (155.01)^2 + (158.6)^2 + (157.16)^2}{3x6} - 5288.204 = 5.08$$

$$P_y = \frac{(311.13)^2 + (209.07)^2 + (96.85)^2}{4X6} - 5288.204 = 957.30$$

$$E_y = 37538.66 - 5.08 - 957.30 = 36576.2809$$

Table 12 Anova Block Design Of Caffeine Content And Drying Process

Source Of Variations	*Dk*	*JK*	*RJK*	F_{Count}	F_{Table}
Average	*1*	*5288.204*	*5288.204*	*-10.09*	*3.15*
Block	*3*	*5.08*	*1.69*		

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Drying	*2*	*957.3*	*478.65*
Experiment Error	*6*	*36576.2809*	*6096.05*
Sampling Error	*60*	*-36256.2*	*-604.27*
Total	*72*	*6300.669*	

$F_{Count} < F_{table}$ then H0 accepted H1 rejected. There is no significant effect of arabica coffee caffeine content on the drying process.

7. Anova with Block Subsampling Design (Arabica Coffee Characteristics and Drying Process)

Table 13 Anova With Block Subsampling Design (Arabica Coffee Characteristics And Drying Process)

Block		*Treatment*				
		Before Drying	*Sun Drying*	*Coffee Drying House*	*Total*	*Average*
	1	*33.5*	*13.2*	*9.66*		
	2	*30*	*14.1*	*9.14*		
	3	*27.4*	*12.8*	*9.2*		
	4	*21*	*15.3*	*10.23*		
	5	*26.7*	*13.7*	*9.32*		
	6	*22.9*	*12.9*	*8.79*		
	J1j	*161.5*	*82*	*56.34*	*299.84*	*16.65778*
Moisture Content (%)	*1*	*34.8*	*14.8*	*9.85*		
	2	*23.4*	*13.4*	*10.15*		
	3	*25*	*15*	*9.7*		
	4	*32.2*	*12.6*	*9.28*		
	5	*34.5*	*14.5*	*8.39*		
	6	*27.1*	*13.1*	*10.68*		
	J2j	*177*	*83.4*	*58.05*	*318.45*	*17.69167*
	1	*30.3*	*15.2*	*12.29*		

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	2	*40.2*	*12.7*	*12.26*		
	3	*24.8*	*14.6*	*12.29*		
	4	*23.7*	*13*	*9.72*		
	5	*41.4*	*15.1*	*9.22*		
	6	*33.7*	*13.5*	*8.56*		
	J3j	*194.1*	*84.1*	*64.34*	*342.54*	*19.03*
	1	*44.4*	*14.4*	*11.22*		
	2	*30.6*	*13.3*	*10.15*		
	3	*33.5*	*14.9*	*9.7*		
	4	*30*	*13.5*	*9.28*		
	5	*27.4*	*15.4*	*8.39*		
	6	*21*	*12.6*	*10.68*		
	J4j	*186.9*	*84.1*	*59.42*	*330.42*	*18.35667*
	1	*12.17*	*8.17*	*3.46*		
	2	*13.25*	*8.46*	*3.09*		
	3	*12.6*	*7.6*	*3.15*		
	4	*14*	*7.87*	*4.9*		
Acidity Content (PH)	*5*	*13.05*	*8.05*	*3.27*		
	6	*12.22*	*8.32*	*2.65*		
	J1j	*77.29*	*48.47*	*20.52*	*146.28*	*8.126667*
	1	*13.4*	*8.38*	*3.67*		
	2	*13.8*	*8.66*	*4.82*		
	3	*12.71*	*8.83*	*3.5*		

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	4	*12.5*	*8.5*	*3.2*		
	5	*13.64*	*8.78*	*2.42*		
	6	*14*	*8.95*	*5.25*		
	J2j	*80.05*	*52.1*	*22.86*	*155.01*	*8.611667*
	1	*12.9*	*8.62*	*6.45*		
	2	*12.4*	*8.89*	*6.4*		
	3	*13.25*	*9.06*	*6.45*		
	4	*13.74*	*8.74*	*3.55*		
	5	*12.02*	*9.02*	*3.17*		
	6	*12.19*	*9.19*	*2.56*		
	J3j	*76.5*	*53.52*	*28.58*	*158.6*	*8.811111*
	1	*12.17*	*8.86*	*5.7*		
	2	*13.25*	*9.14*	*4.82*		
	3	*12.6*	*9.31*	*3.5*		
	4	*14*	*8.98*	*3.2*		
	5	*13.05*	*9.26*	*2.42*		
	6	*12.22*	*9.43*	*5.25*		
	J4j	*77.29*	*54.98*	*24.89*	*157.16*	*8.731111*
	1	*11.15*	*4.56*	*1.71*		
	2	*12.85*	*3.65*	*1.65*		
Caffeine Content (%)	*3*	*12.01*	*4.75*	*1.6*		
	4	*11.21*	*4.7*	*1.55*		
	5	*12.93*	*4.63*	*1.86*		

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6	*12.07*	*4.37*	*2.25*		
J1j	*72.22*	*26.66*	*10.62*	*109.5*	*6.083333333*
1	*11.27*	*4.24*	*1.95*		
2	*12.99*	*4.05*	*1.35*		
3	*12.13*	*3.9*	*1.79*		
4	*11.33*	*3.35*	*1.63*		
5	*13.05*	*3.95*	*2.53*		
6	*12.19*	*3.75*	*1.15*		
J2j	*72.96*	*23.24*	*10.4*	*106.6*	*5.922222222*
1	*11.39*	*4.13*	*1.1*		
2	*13.11*	*3.8*	*1.05*		
3	*12.25*	*3.55*	*1*		
4	*11.45*	*4.01*	*1.84*		
5	*13.17*	*3.6*	*1.65*		
6	*12.31*	*3.45*	*2.4*		
J3j	*73.68*	*22.54*	*9.04*	*105.26*	*5.847777778*
1	*11.51*	*3.85*	*0.8*		
2	*13.23*	*3.5*	*0.75*		
3	*12.37*	*3.3*	*1.79*		
4	*11.57*	*3.7*	*1.63*		
5	*13.29*	*3.4*	*2.53*		
6	*12.43*	*3.25*	*1.15*		
J4j	*74.4*	*21*	*8.65*	*104.05*	*5.780555556*

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Big Quantity	*1323.89*	*636.11*	*373.71*	*2333.71*	
Average	*24.51648148*	*11.77981481*	*6.920555556*		*14.40561728*

Research Hypothesis:
H0 = No Effect of Arabica Coffee Characteristics on the Drying Process
H1 = There is an Effect of Arabica Coffee Characteristics on the Drying Process

$$\sum Y^2 = 39864.07$$

$$R_y = \frac{(233.71)^2}{12x6x3} = 252.87$$

$$S_b = \frac{(161.5)^2 + (82)^2 + (56.34)^2 \dots\dots\dots + (74.4)^2 + (21)^2 + (8.65)^2}{12 * 6} - 252.87 = 2992.63$$

$$S_y = 39864.07 + 252.87 + 2992.63 = 43109.57$$

$$B_y = \frac{(299.84)^2 + (318.45)^2 + \cdots \dots\dots\dots + (105.26)^2 + (104.05)^2}{12 * 6} - 252.87 = 7502.19$$

$$P_y = \frac{(1323.89)^2 + (636.11)^2 + (373.71)^2}{3x6} - 252.87 = 127357.12$$

$$E_y = 2992.63 - 7502.19 - 127357.12 = -131867$$

Table 14 Anova With Block Subsampling Design (Arabica Coffee Characteristics And Drying Process)

Source Of Variations	*Dk*	*JK*	*RJK*	F_{Count}	F_{Table}
Average	*1*	*252.87*	*252.87*		
Block	*2*	*7503.19*	*3751.6*		
Drying	*2*	*127357.12*	*63678.56*	*-2.9*	*3.15*
Experiment Error	*6*	*-131867*	*-21977.8*		
Sampling Error	*204*	*43109.57*	*211.32*		
Total	*216*	*39864.07*			

The conclusion is that $F_{Count} < F_{Table}$, which means that there is no significant effect of arabica coffee characteristics on the drying process.

8. Factorial Design of Arabica Coffee Characteristics and Drying Process

Table 15 Factorial Design Of Arabica Coffee Characteristics And Drying Process

A\B	*Treatment*			*Total*	*Average*
	Before Drying	*Sun Drying*	*Coffee Drying House*		
Moisture Content(%)	*26.92*	*13.67*	*9.39*		
	29.5	*13.9*	*9.68*		

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	32.35	*14.02*	*10.72*		
	31.15	*14.02*	*9.9*		
Total	*119.92*	*55.61*	*39.69*	*215.22*	
Average	*29.98*	*13.9025*	*9.9225*		*17.935*
	12.88	*8.08*	*3.42*		
Acidity Content (PH)	*13.34*	*8.68*	*3.81*		
	12.75	*8.92*	*4.76*		
	12.88	*9.16*	*4.15*		
Total	*51.85*	*34.84*	*16.14*	*102.83*	
Average	*17.28333333*	*11.61333333*	*5.38*		*11.43*
	12.04	*4.44*	*1.77*		
Caffeine Content(%)	*12.16*	*3.87*	*1.73*		
	12.28	*3.76*	*1.51*		
	12.4	*3.5*	*1.44*		
Total	*48.88*	*15.57*	*6.45*	*70.9*	
Average	*16.29333333*	*5.19*	*2.15*		*7.88*
Big Quantity	*220.65*	*106.02*	*62.28*	*388.95*	
Average	*18.3875*	*8.835*	*5.19*		*10.8*

Research Hypothesis:
H0 = No Effect of Arabica Coffee Characteristics and Drying Process on Arabica Coffee Flavors
H1 = There is an Effect of Arabica Coffee Characteristics and Drying Process on Arabica Coffee Flavor

$$\sum Y^2 = 6491.228$$

$$R_y = \frac{(388.95)^2}{4x3x3} = 4202.28$$

$$A_y = \frac{(215.22)^2 + (102.83)^2 + (70.9)^2}{3x3} - 4202.28 = 2677.772$$

$$B_y = \frac{(220.65)^2 + (106.02)^2 + (62.28)^2}{3x3} - 4202.28 = 2887.216$$

J_{ab} = 1/3{$(119.92)^2$ + $(55.61)^2$ + $(39.69)^2$ + $(51.85)^2$ + $(34.84)^2$ + $(16.14)^2$ + $(48.88)^2$ + $(15.57)^2$ + $(6.45)^2$ /3-4202.28}=1475.307

AB_y = 1475.307 – 2677.772 – 2887.216 = -4089.68

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$E_y = 6491.228 – 4202.28 – 2677.772 – 2887.216 + 4089.68 = 813.64$

Table 16 Factorial design of Arabica coffee characteristics and drying process on the flavor of Arabica coffee

Source Of Variations	*Dk*	*JK*	*RJK*	F_{Count}	F_{table}
Average	*1*	*4202.28*	*4202.28*	*54.3*	*3.28*
Treatment : Drying Process	*2*	*2677.772*	*1338.886*		
Error	*33*	*813.64*	*24.66*		

$F_{Count} > F_{table}$ then H0 is rejected H1 is accepted. There is a significant effect of arabica coffee characteristics and drying process on arabica coffee flavor.

IV. CONCLUSION

The following are the results of data processing with a fixed model analysis of variance with one way annova, analysis of variance with a subsampling block design and by using a two way annova factorial design analysis of variance so that it can be concluded, using the drying method with a coffee drying house can produce coffee with lower moisture content, acidity, and caffeine value, as well as a sweeter taste and also the quality of coffee produced is in accordance with coffee export standards. In addition, based on the results of the research hypothesis that has been carried out, the value of the Fhitung> Ftabel test is 545.377> 9.55 and for the significance value is 0.000 <0.005, which means that H0 is rejected H1 is accepted, which means that the moisture content, acidity value, caffeine value and coffee drying process using a coffee drying house affect the taste of arabica coffee.

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