CHARACTERISTICS OF COLD BREWED ARABICA COFFEE FROM GUNUNG KARAMAT VILLAGE SUBANG REGENCY AS A RESULT OF DIFFERENT TEMPERATURES AND ROASTING TIME

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KARAKTERISTIK SEDUHAN DINGIN KOPI ARABIKA ASAL DESA GUNUNG KARAMAT KABUPATEN SUBANG HASIL PERLAKUAN SUHU DAN LAMA PENYANGRAIAN YANG BERBEDA

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ABSTRACT

Cold brewed coffee has a sweet taste steeping intensity higher than bitter taste and sour taste. One of the flavors of brewing coffee can be affected by the temperature and the roasting time of the equipment used. In this study, cold brewing processes were performed on several Arabica coffee samples obtained from several roasting treatments consisting of three different roasting temperatures (170°C, 180°C, and 190°C) and three levels of roasting times (10, 12, and 15 minutes). The cold brewed in this study has the characteristics of steeping with high acidity intensity, clean aftertaste, the color of the steeping tends to be light brown, and the steeping body was light. The best treatment for roasting was a temperature of 190°C with a roasting time of 10 minutes based on the highest effectiveness value.

ABSTRAK

Kopi seduh dingin memiliki intensitas seduhan rasa manis lebih tinggi daripada rasa pahit dan asam. Cita rasa pada seduhan kopi salah satunya dapat dipengaruhi oleh suhu dan lama waktu penyangraian dari alat yang digunakan. Pada penelitian ini, proses penyeduhan kopi dilakukan pada beberapa sampel Arabika kopi yang diperoleh dari beberapa perlakuan penyangraian yang terdiri dari tiga suhu sangrai yang berbeda (170°C, 180°C, and 190°C) dan tiga tingkat waktu sangrai (10, 12, dan 15 menit). Kopi seduh dingin pada penelitian ini memiliki karakteristik seduhan dengan intensitas keasaman tinggi, clean aftertaste, warna seduhan cenderung coklat muda, dan body seduhan ringan. Perlakuan terbaik untuk penyangraian adalah suhu 190°C dengan waktu penyangraian 10 menit berdasarkan nilai bobot efektifitas tertinggi.

INTRODUCTION

Arabica coffee is included in the coffee beans that have the best quality compared to other types of coffee. This type of coffee is able to produce a distinctive coffee taste and has different biochemical content (caffeine, trigonelline, chlorogenic acid, and sucrose), one of which is based on the area of origin of the coffee beans *(Isnidayu et al., 2020)*. Environmentally Arabica coffee is widely cultivated in areas with an altitude of 610-1830 meters above sea level (MASL), while robusta coffee can be grown in the lowlands, in areas with an altitude of 0-800 MASL *(Darmajana et al., 2022)*. Subang Regency is one of the regions or centers for smallholder Arabica coffee with a total production of 66 tons in 2015-2018 *(Direktorat Jenderal Perkebunan, 2019)*, while in 2019 it increased by 45% with a total production of 120 tons *(Direktorat Jenderal Perkebunan, 2020)*. This production value shows the need for efforts to maintain and increase the productivity of Arabica coffee, especially in Subang Regency in order to be able to compete in the national market, one of which is through processing coffee in the form of coffee powder or processed into cold brewed coffee drinks.

Brewed coffee can have different flavors. The difference in the taste of brewing coffee can be influenced by several factors, one of which is the temperature of the brewing water. Brewing coffee based on the temperature of the brewing water consists of two methods, i.e., high water temperature (hot brewed) and low water temperature (cold brewed) *(Cordoba et al., 2021)*. People in Indonesia generally consume coffee with high water temperatures such as the Aero press, expresso, French press, and *tubruk (Bekti et al., 2019)*.

Cold brewed coffee is a term for serving brewed coffee whose extraction process uses room temperature water or cold water *(Dharmawan, 2017)*, with a serving process that takes 8 to 24 hours *(Cordoba* *et al., 2019)*. This method has a lower total acidity value, so the resulting taste tends to be sweeter than hot brewed coffee *(Rao and Fuller, 2018)*. The quality of the taste of brewed coffee can be obtained by paying attention to the roasting factor of coffee beans. Roasting can be defined as the process of processing coffee beans that can determine the quality of the coffee drink produced. This process can convert raw coffee beans into processed coffee drinks that have a delicious aroma and taste *(Afriliana, 2018)*. In addition, the quality of the brewed coffee produced can also be influenced by the heating technique or the type of equipment used for roasting.

Roasting machines are generally available in the drum type with a heating system in the form of a fire source originating from LPG gas in direct contact with the rotating cylinder. This equipment is less efficient in roasting because of the large amount of heat lost due to combustion produced from LPG, there is no heating furnace as a coating, so the heat generated is wasted a lot to the environment *(Rusnadi et al., 2018)*. In addition, coffee roasting with an electric heating source is also available, but the roasting time required is longer (34-58 minutes) and the price is relatively expensive for small industrial scales *(Maulina et al., 2022)*. One of the efforts to increase roasting efficiency is to design a roasting machine with an infrared heating source. This machine is more efficient in energy use *(Hidayat et al., 2020)*. However, to determine the efficiency of using a roaster with an infrared is necessary to study further the use of different temperatures and roasting times on the Physicochemical and organoleptic quality characteristics of cold brewed Arabica coffee.

MATERIALS AND METHODS

The main materials used were Arabica coffee beans obtained from Gunung Karamat village, Ciater District, Subang Regency, 12 kg LPG gas, V60 coffee filter paper, buffers pH 4 and 7, standard caffeine, methanol, demineralized water, and distilled water. The main equipment used was the first generation of drum roasting machine developed by *Hidayat et al. (2020)*, digital scales, refrigerator, coffee color tracker, coffee grinder, colorimeter, portable refractometer, oven, TDS meter, pH meter, HPLC, spoon and glass cupping 200 ml.

Sample preparation

The process of making Arabica coffee powder were divided into 5 stages namely, (1) the coffee beans were sorted first; (2) coffee beans roasted in 926 g/batch with treatments roasting temperatures were 170ºC, 180ºC, 190ºC, and roasting times were 10, 12, and 15 minutes; (3) The roasted coffee beans were stored (resting time) at seven days to reduce the carbon dioxide levels that were still lifting after roast; (4) The roasted coffee beans were grinding by using a self-developed coffee grinder (PRTT BRIN) with a medium grinding size; (5) The powder coffee were then sieved using a 20 mesh sieve and stored using zip-lock aluminum foil packaging.

The process of brewing coffee using the cold brewed coffee method was divided into 4 stages, viz. (1) weighing 16 g of coffee powders; (2) The coffee powder were put in a glass jar and 160 ml of cold water (4ºC) was added gradually until the coffee powders were submerged; (3) The glass jar containing the soaked coffee was then stored in the refrigerator for 8 hours for the extraction of the coffee process; (4) Arabica coffee that has passed the extraction process was then filtered using a V60 dripper and coffee paper filter to separate the extraction results from the coffee powders.

Physicochemical analysis

The physicochemical analysis evaluated in this study were color (brightness), Total Dissolved Solid, sucrose content, water content, pH, and caffeine content. The color (brightness) of coffee powder was measured using a colorimeter (3NH Technology Co., Ltd., Shenzen, China). The value of TDS brewed coffee was measured by TDS meter (Jinan Huiquan Electronic Co., Ltd., Shandong, China). This test was carried out to see the total dissolved solids expressed in ppm units. The water content of coffee powder was measured using the oven method which refers to SNI 2983:2014 *(BSN, 2014)*, where the coffee powder was dried in the oven for 1 hour, then the sample was weighed. The water content was calculated based on the initial and final weights of the sample. The degree of acidity (pH) was tested using a pH meter (Jinan Huiquan Electronic Co., Ltd., Shandong, China).

The electrode was dipped into the brewed coffee until the pH meter display shows a stable number. The sucrose level indicates the sugar concentration of the brewed coffee. It was measured by using a hand-held Refractometer ATAGO PAL-1 (Atago Co.,Ltd., Tokyo, Japan).

The caffeine content of brewed coffee was measured by using a High-Performance Liquid Chromatography instrument (Agilent Technologies, Inc., California, United States).

Organoleptic taste

Organoleptic test of cold brewed Arabica coffee was performed using the hedonic method (preferred test). The test parameters carried out consisted of attributes of color, aroma, taste, aftertaste, and overall. The sample was evaluated by 25 untrained panelists (barista). There were 27 samples that were evaluated by the panelists and were given a score in the range of 1 to 7 points (1= Really liked, 2= Liked, 3= Somewhat liked, 4= Moderately, 5= Slightly disliked, 6= Disliked, 7= Really disliked).

RESULTS

Total dissolved solid (TDS)

TDS is the amount of substances dissolved in water when the sample is brewed such as organic or inorganic substances *(Borem et al., 2016)*. The results of this study show that the highest TDS value of cold brewed Arabica coffee is 216,06 ppm at 180°C for 15 minutes, while the lowest TDS is 190.39 ppm at 190°C for 10 minutes (Table 1).

Table 1

The data analysis of the physicochemical quality test of cold brewed Arabica coffee

Sample	Color (Lightness)	Total Dissolved Solid (ppm)	pH	Sucrose Content (Brix%)	Moisture Content (% w/w)	Caffeine (%)
170ºC; 10 minutes	44.13	195.87	4.67	1.75	3.18	0.10
170ºC; 12 minutes	41.98	210.48	4.65	1.75	2.49	0.10
170ºC; 15 minutes	38.35	215.90	5.52	1.11	1.80	0.11
180ºC; 10 minutes	43.02	206.01	4.59	1.91	2.75	0.12
180ºC; 12 minutes	41.42	212.92	4.69	1.59	2.21	0.10
180ºC; 15 minutes	38.55	216.06	5.49	1.27	1.92	0.11
190ºC; 10 minutes	43.76	190.39	4.58	1.43	2.73	0.10
190ºC; 12 minutes	40.12	212.65	4.78	1.43	1.85	0.11
190ºC; 15 minutes	37.96	215.35	5.53	1.27	1.61	0.11

This shows that the increasing use of temperature treatment and roasting time results in an increase in the steeping TDS value. According to *Rao et al. (2020)*, although during the roasting process decomposition of compounds occurs which can cause the loss of dissolved solids, new compounds are also formed during the pyrolysis stage which occurs during the dark roasting. In addition, the more intense roasting process can damage the cellular matrix so that the compounds are more easily extracted. The amount of dissolved solids is limited by the use of the brewing water temperature. According to *Cordoba et al. (2019),* the cold brew coffee method has a TDS value that is close to or higher than hot coffee because the extraction temperature is assumed to be the driving force that supports the extraction process of chemical compounds present in coffee powders. This study did not identify specifically the type of solute contained in brewing coffee, so it only measured the overall amount of solute produced in brewing coffee. However, some literature shows that the total dissolved solids content is composed of organic and inorganic substances such as acids, sugars, and salts so that when the salt dissolution is carried out the higher the total dissolved solids value that is read will increase *(Pamungkas, 2016; Nurhayati, 2017)*. In addition, dissolved solids in cold brew coffee can be caffeine, phenol, chlorogenic acid, esters, and organic acids. These compounds contribute to the taste and aroma of the extracted coffee *(Kyroglou et al., 2022)*.

Degree of acidity (pH)

The pH analysis is one of the analytical parameters that can show the concentration of hydrogen ions which states the level of acidity or alkalinity in a solution *(Sudewa and Hadiatna, 2017)*. The pH value of coffee does not represent a sour taste that can be accepted by coffee consumers but is more likely to be used as a parameter of stability and quality of the results of coffee processing such as roasting *(Davids, 2003; Umam, 2017)*.

The results of this study show that the pH value of cold brewed Arabica coffee has the highest value of 5.53 at a temperature treatment of 190°C for 15 minutes, while the lowest pH value is 4.58 at a temperature treatment of 190°C for 10 minutes (Table 1).

The acid contained in coffee when the roasting process undergoes evaporation can cause the acidity of cold brewing Arabica coffee to tend to decrease or the resulting pH value to increase with increasing use of temperature and roasting time. This statement is in accordance with the research results of *Purnamayanti et al. (2017)*, the pH value increases towards a neutral pH value along with the higher and longer the roasting process. This can happen because during the roasting process there are changes in the physical and chemical properties of coffee. According to *Cuong et al. (2014)*, the roasting process will degrade various important compounds found in coffee such as chlorogenic acid, trigonelline, protein, and polysaccharides. These factors can then affect the solubility and availability of organic compounds during coffee brewing so that the pH value of brewing coffee produced can vary.

Sucrose content

Brix value is used as the percentage of dissolved sugar in a solution, higher the value the better taste of brewing coffee *(Maulid et al., 2021)*. This study shows that the highest level of cold brewed Arabica coffee sucrose is 1.91% Brix is found at a temperature treatment of 180°C for 10 minutes, while the lowest is 1.11% Brix is found at a temperature treatment of 170°C for 15 minutes (Table 1). Coffee beans when roasted go through a chemical phase in the form of a caramelization reaction. When passing through this phase, the sugar content in the coffee beans will be degraded and a distinctive coffee taste is formed, but if the coffee beans are exposed to excessive heat, the sugar content in the coffee beans will burn so that the brix% value of brewing coffee produced decreases. This statement can be supported by the literature, which shows that the decrease in the value of Brix in brewed coffee can be caused when the roasting processed coffee beans undergo a caramelization reaction. The reaction can convert sugar monomers into furan and hydroxymethylfurfural, which can cause a decrease in the Brix value in coffee steeping *(Yeretzian et al., 2002; Maulid et al., 2021)*. The Brix value of coffee after roasting will decrease because some of the sucrose undergoes hydrolysis, but some will undergo pyrolysis *(Illy and Viani, 2005; Henrietta, 2020)*.

Moisture content

The water content value shows the amount of water content per unit weight of the material expressed in units of percent on a wet basis or a dry basis to maintain the shelf life of coffee *(Edowai, 2019)*. This study shows that the highest water content of coffee powder is found at a temperature of 170°C for 10 minutes with a water content value of 3.18% w/w, while the lowest water content value is 1.61% w/w at a temperature treatment of 190°C for 15 minutes (Table 1). Roasted coffee beans will go through a water evaporation phase which can cause the water content in the coffee beans to come out due to the help of heat. According to *Setyani et al. (2018)*, the water content of coffee after roasting tends to decrease along with the increase in temperature and duration of roasting of coffee beans. This can happen because the roasting process is related to the rapid propagation of water (diffusion) in the coffee bean cell tissue. Based on the data that had been obtained, the average value of the water content of coffee powders has a value of 1.61-3.18% w/w was indicates that the results obtained have met the quality requirements of SNI 01-3542-2004 for the I and II quality requirements. The water content of powder coffee is not more than 7% w/w *(BSN, 2004)*.

Caffeine content

The concentration of caffeine levels can indicate the strength, body, and bitterness of brewed coffee *(Angeloni al., 2019).* This study showed that the caffeine content of cold brew Arabica coffee did not have a significantly different value. The highest caffeine content was found at 180°C for 10 minutes with a caffeine content of 0.12%, while the lowest caffeine content value was 0.10% at 170°C for 10 minutes (Table 1). The instability of the value of the caffeine concentration in brewing coffee can be influenced by different temperatures and roasting time used and the changes in the physical shape of the roasted coffee beans, one of which is the development of volume in the coffee beans. Research by *Folmer (2012)* and *Kristandi (2018)* shows that the cause of changes in coffee bean caffeine levels during the roasting process is due to structural changes in the cells of the coffee beans. Changes in the structure of coffee beans can determine the increase or decrease in the level of caffeine produced. Based on research data that has been obtained, the average value of cold brewed Arabica coffee has a value of 0.10-0.12%. The caffeine content of cold brewed Arabica coffee, when compared with the value caffeine content of hot brewed coffee has a percentage difference of 89.014-90.610%. The value can be seen in previous research referring to *Rao et al (2020)*, the average value of the caffeine content of hot brewed coffee is 1.035-1.095%.

Organoleptic test result

Aroma Test Analysis in brewing coffee will have different translations from one person to another like in the coffee taste *(Yulia, 2018)*. The hedonic test of the aroma attribute of brewed coffee that the panelists preferred was coffee treated with a temperature of 180°C for 10 minutes, while the panelist not preferred was coffee with a temperature treatment of 180°C for 15 minutes.

The aroma of brewed coffee favored by the panelists has a higher acidity value because the acid compounds that form the aroma and taste in this treatment have not been decomposing much more than coffee that has been roasting for a longer time. According to research *Rao (2014)* and *Amri et al. (2021)* roasting levels of light to medium produce coffee with flavor positive fruity, floral, nutty, and sweet caramel. In addition, the roasting process with a long time will pass through the pyrolysis phase, which can cause various volatile acid compounds as described in *Nopitasari (2010)*, the roasting process of coffee beans at the final stage of pyrolysis occurs degradation of carbohydrate, fat, and protein compounds which can produce volatile acid compounds (formic acid, propanoic acid, acetic acid, and hexanoic acid). According to *Rao et al. (2011)*, a collection of these compounds can only be formed when roasting is carried out. Therefore, when many volatile components dissolve in water during the coffee brewing process, the sharper the coffee brewing fragrance will be.

The color attribute is one of the parameters that can determine the level of panelists' interest in the cold brew of Arabica coffee produced. The hedonic test of the coffee brewing color attribute that the panelists preferred was coffee with a temperature treatment of 180°C for 10 minutes, while the least preferred was coffee with a temperature treatment of 180°C for 15 minutes. Panelists prefer coffee brewed with a brown color rather than dark color. The color of the brewed coffee produced can be influenced because of the increasing use of roasting degrees, so the brewing color of the coffee produced tends to be close to dark brown. This statement is in accordance with the research According to *Vignoli et al. (2014)*, the intensity of the color of the brewed coffee produced is due to the presence of melanoidin compounds. In addition, the color of steeping coffee can be affected by the caramelization reaction due to the presence of caramel compounds that can produce a dark brown color. According to *Kusnandar (2019)*, caramelization reactions are included in reactions that involve simple sugars so that they can give a caramel brown color and form flavor components.

Table 2

The results of the organoleptic quality test analysis of cold brewing Arabica coffee

Sample	Aroma	Color	After-taste	Flavor	Overall
170ºC; 10 minutes	2.93	2.93	2.84	2.85	2.90
170ºC; 12 minutes	3.29	3.15	3.60	3.57	3.39
170ºC; 15 minutes	3.52	3.75	4.91	4.51	4.19
180ºC; 10 minutes	2.77	2.55	3.01	2.85	2.88
180ºC; 12 minutes	3.20	3.00	3.09	3.19	3.17
180ºC; 15 minutes	4.63	3.28	5.27	5.41	4.70
190ºC; 10 minutes	3.33	3.07	3.29	3.28	3.24
190ºC; 12 minutes	2.93	3.37	3.85	3.39	3.40
190ºC; 15 minutes	4.47	3.64	5.16	5.24	4.67

The after-taste attribute aims to give the impression that is sensed by the palate regarding the aroma and taste of brewed coffee after the coffee is swallowed *(SCAA, 2015)*. The assessment of this attribute can be felt as a taste that is left on the base of the tongue when tasting like something is slightly stuck in the throat, or when tasting brewed coffee nothing is left or can be said to be clean (clean) like not drinking coffee *(Yulia, 2018)*. After-taste of cold brewed Arabica coffee that panelists like is coffee with a temperature treatment of 170°C for 10 minutes, while what is not preferred is coffee with a temperature treatment of 180°C for 15 minutes (Table 2). Brewed coffee with a pleasant aftertaste can be felt a few moments after the coffee is swallowed. According to *Budiyanto et al. (2021)*, the after-taste score (preferred by panelists) indicates that there are variations in taste and aroma that give the impression and taste favored by panelists at the end of the test. Research results from *Puspitasari (2020)* show that the longer roasting time has the aftertaste (not favored by panelists) because it detects a sour taste formed by the content of acidic compounds (phenolic acid, chlorogenic acid, and aliphatic acid) increasing so that there is the taste that lingers when the coffee is sipped.

Taste attributes in organoleptic can be done based on the influence, complexity, and quality of the combination of aroma and taste when coffee is sipped in the mouth so that it can involve the entire palate. Non-volatile organic compounds and minerals are flavor-forming compounds that can be produced by the sense of taste in the liquid phase *(Mulato and Suharyanto, 2012)*. The hedonic test of the coffee brewed taste attribute that the panelists liked was coffee treated with a temperature of 180°C for 10 minutes, while the taste that the panelists did not like was coffee with the treatment 180°C for 15 minutes. The panelist's assessment was quite sensitive to the brewing taste of the coffee produced because the temperature treatment at 180°C for 10 minutes had a higher Brix value and caffeine content than the treatment at 180°C for 15 minutes.

These parameters indicate that the brewed coffee produced has a balanced brewing taste between sweet and bitter tastes. In accordance with the research of *Maulid et al. (2021)*, which shows that the Brix value is used as the percentage of dissolved sugar in a solution, the higher the value, the better the brewed coffee tastes. According to *Sunarharum et al. (2014),* a roasting time that is too long can affect the taste of the coffee produced, namely the dominant charred and bitter taste because, during the roasting process, chlorogenic acid will be broken down into quinine lactic acid, quinine acid, ferulic acid, caffeic acid, and lactone chlorogenic acid which have a sour taste. strong bitterness in brewing coffee. According to *Cordoba et al. (2019)*, cold brew coffee requires a long extraction time so it can cause degradation of compounds and the formation of off-flavor in coffee brewing.

The overall test of cold brewing arabica coffee was carried out with the aim of knowing the panelists' assessment of the observed coffee steeping (aroma, color, taste, and aftertaste). The results showed that overall, the coffee that was liked by the panelists was roasted coffee at 180°C for 10 minutes, while the coffee they disliked the most was coffee roasted at 180°C for 15 minutes. The treatment favored by the panelists resulted in the characteristics of steeping coffee with a higher intensity of acidity, having a pleasant aftertaste or no taste left in the throat, and the color of brewing coffee tended to be light brown. In this study, the results of the assessment by the panelists were in line with the literature from *Amri et al. (2021)*, where roasted coffee with a medium level was preferred because the quality of flavor, clean-up, aroma, and overall was higher than other roasting treatments. In addition, the resulting flavor and aroma character was quite dominated by floral, sugar browning, and slightly fruity.

Effectiveness value

The effectiveness value can be determined based on the effective index method to know the best treatment of temperature and roasting time coffee beans Arabica from Gunung Karamat Village, Subang Regency. The best temperature and roasting time are determined based on the Physicochemical analysis parameters (color, TDS, pH, water content, caffeine content, and sucrose content) and organoleptic (aroma, color, taste, aftertaste, overall). The best treatment in this study was at a temperature of 190°C for 10 minutes because it had the highest effectiveness value of 0.91. This treatment resulted in the characteristics of arabica coffee with a color value of 43.76 L (brightness), TDS brewed coffee 190.39 ppm, pH brewed coffee 4.58, sucrose content of 1.43%Brix, the water content of coffee powder 2.73% w/w, and the caffeine content of cold brewed Arabica coffee is 0,10%. The organoleptic test value of cold brewed Arabica coffee for the color attribute was 3.07 (somewhat liked), the aroma attribute was 3.33 (somewhat like), the taste attribute was 3.28 (somewhat like), the aftertaste was 3.29 (somewhat like), and 3.24 overall (somewhat like). The effectiveness value of cold brewing Arabica coffee as a result of different temperatures and roasting times can be seen in Table 3.

Table 3

Results of analysis of the effectiveness of cold brewing Arabica coffee

Sample	EV	Sample	EV	Sample	EV
170ºC; 10 minutes	0.77	**180ºC; 10 minutes**	0.66	**190ºC; 10 minutes**	0.91
170ºC; 12 minutes	0.60	**180ºC; 12 minutes**	0.66	**190ºC; 12 minutes**	0.55
170ºC; 15 minutes	0.40	**180ºC; 15 minutes**	0.28	**190ºC; 15 minutes**	0.28

Note: EV is effectiveness value

CONCLUSIONS

Based on the research data, the combination of different temperatures and roasting times resulted in the physicochemical quality characteristics of cold brewed Arabica coffee which varied with the TDS (Total Dissolved Solid) value of brewed coffee 190.39-216.06 ppm, pH 4.58-5.53, sucrose content 1.11-1.91 %Brix, and caffeine content 0.10-0.12%. Cold brewing Arabica coffee based on the overall organoleptic test was the most preferred by the panelists in the treatment at 180°C for 10 minutes because the treatment had the characteristics of steeping coffee with high acidity intensity, the aftertaste of the coffee was clean or there was no taste left in the throat, the brew color tended to be light brown, and the body attribute was light. The best roasting temperature and time can be obtained based on the highest effectiveness value, namely the treatment at 190°C for 10 minutes.

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