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Mim Coffee Lab
Analysis and Evaluation of CAFEC Coffee Filters: T-92, T-90, T-83, and Abaca+.

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Analysis and Evaluation of CAFEC Coffee Filters: T-92, T-90, T-83, and Abaca+

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Introduction

Within the complex dynamic world of the coffee industry, filters are among the most important elements at play that help determine the final quality of beverages. Indeed, each filter may dominate with particular characteristics over the aroma, flavor, and even appearance of the coffee. With so many varieties available, choosing the right coffee filter will optimize the brewing process and maximize the coffee-drinking experience.

In this report, we will describe and compare three types of CAFEC coffee filters: T-92, T-90, and T-83, using Abaca+ as a reference sample. All these filters are designed to respond precisely to the needs of every coffee maker and to the different characteristics which each kind of coffee may have, for the single purpose of optimizing the beverage and final cup quality.

Being of high density with one-sided crepe, the T-92 filter helps manufacture a strong aroma and a clean cup. This type of filter is meant for those who need a coffee with a strong fragrance and a minimum of fine coffee grounds in a cup. The T-90 filter, on the other hand, has a double-sided crepe with lower density, hence it allows the production of balance and desirable flavor in the final coffee. Its balancing properties in medium-roasted coffees make it ideal, balanced, and pleasant. Finally, the T-83 filter, made of double-sided crepe material and with very low height, is designed to enhance the body and sweetness of the coffee. The optimal filter for those who like dark-roasted coffees or for whoever wants sweetness and complexity in their cup of coffee.

The ultimate objective of this report is to assess and compare these three coffee filters against the claims made by the producing company, CAFEC. This is achieved through thorough and comprehensive tests conducted on the filters under very controlled conditions, using high-tech equipment and a variety of coffees with different levels of roast. Such tests will discuss the effects that each filter has on every characteristic of coffee brewing time, weight of extract, and measurements of pH, TDS, Brix, and extraction yield.

This report provides an overall introduction to each of the filter specifications, methods of production, and experimental analyses. Additionally, the outcomes from various comparisons will be examined in detail to offer a better understanding of how each filter affects the final coffee quality. These analyses can assist baristas, coffee enthusiasts, and consumers in making informed decisions when selecting the right filter, thereby enhancing their coffee-drinking experience. Next, we will delve into the specifics of each filter and the results of the experiments.

T-92 filter

Specifications of T-92 filter:

- Designed for producing good aroma and a clean cup.
- Thickness: 0.15 mm.
- High density.
- One-sided crepe (smooth on the inside and creped on the outside).
- Optimal brewing temperature: 92 degrees Celsius.
- Internal paper of this filter doesn't have any crepe, so the internal surface area is smaller compared to other CAFEC filters. During brewing, fine coffee grounds block this smaller area, and it leaves little room for water to pass through. As a result, water will be built up inside this paper filter, and abundant aroma extraction can be attained. Furthermore, due to the outer crepe, brewed coffee flows out softly.
- This density of the paper means it is mostly void of particles within the cup, and hence can give a very clean coffee experience.
- The irregular texture felt in the paper filter does not constitute crepe; however, it is a result of the manufacturing process.

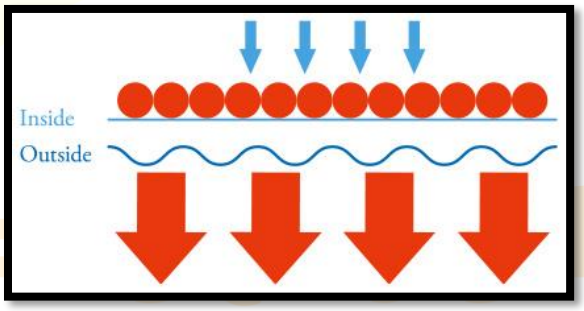


Figure 1. Structure of T-92 filter

Manufacture Process

T-92 filter is a product of the production process where the roller rotates at a higher speed compared to the rotating drying drum. This difference in rotating speed is lesser compared with one used during paper production for dark roasting and enables the wet paper to loosen at a part of this machine called Creping doctor blade. It is an especially essential method of acquiring the right texture and density of the filter paper, leading to its special brewing features and overall performance.

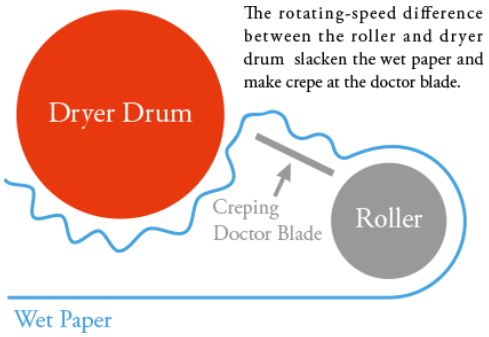


Figure 2. Production method of T-92 filter

T-90 filter

Specifications of T-90 filter:

- Designed to create balance in the final coffee and a good flavor.
- Thickness: 0.28 mm.
- Low density.
- Double-sided crepe (providing balanced and optimal height).
- Optimal brewing temperature: 90 degrees Celsius.
- The water flows easily through the filter due to its well-balanced double-sided crepe. Its top surface area is more open compared to the other two filters, which keeps it open to water passage even at the end of the brewing process when full of fine coffee grounds. This consequently provides a cup with a balanced flavor and rich taste.

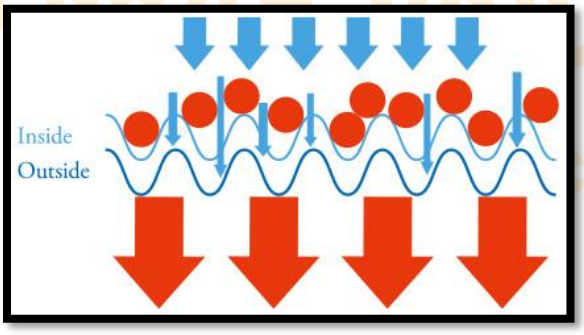


Figure 3. Structure of T-90 filter

Manufacture Process

Air drying process; the wet paper is laid flat and then dried by means of warm air, enabling the paper to retain an even shape when dry. This process of air drying enables filter paper to retain its

structure, supporting smooth water flow and contributing to the production of a rich, balanced cup of coffee.

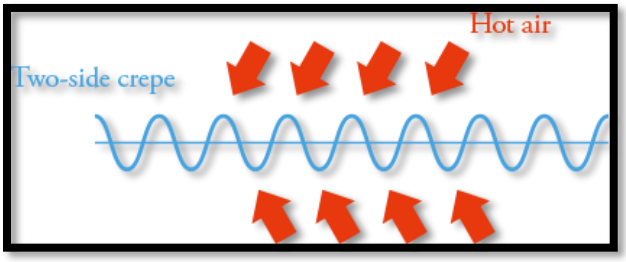


Figure 4. Production method of T-90 filter

T-83 filter

Specifications of T-83 filter:

- Designed to create body and good sweetness in the final coffee.
- Thickness: 0.22 mm.
- Medium density.
- Double-sided crepe (with low height).
- Optimal brewing temperature: 83 degrees Celsius.
- The T-83 filter features a double-sided crepe design, with only a slightly lower height adjustment. Its surface area is also somewhat bigger compared to a one-sided crepe filter, and the fine coffee grounds have more space for adhesion. During the brewing process with this filter, in the first half, the adhesion of the coffee grounds is not very high, allowing water to flow more freely. However, in the latter half of the brewing process, the adhesion increases, somewhat slowing down the water flow. As a result, the initial flow is fast, followed by a slower flow of water, yielding a coffee with an acceptable body and sweetness.

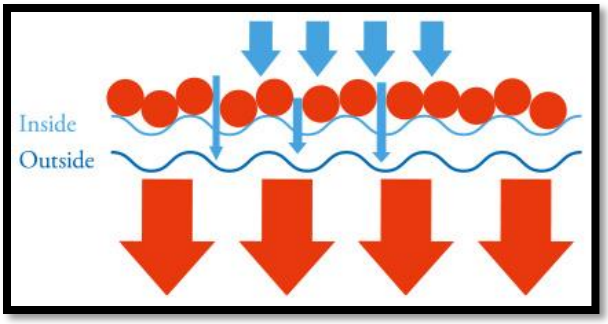


Figure 5. Structure of T-83 filter

Manufacture Process

In the production process of the T-83 filter, the roller spins faster than the drying drum, similar to the T-92 filter. This difference in rotational speed (which is greater than that used when producing paper for light roasting) allows the wet paper to loosen at a section of the machine known as the Creping doctor blade. The double-sided crepe is formed due to this speed differential and dries on the drum. As a result, this filter undergoes less drying compared to filters dried through air, contributing to its unique texture and performance characteristics in brewing.

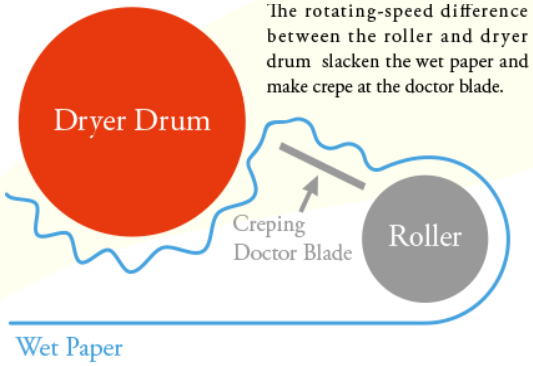


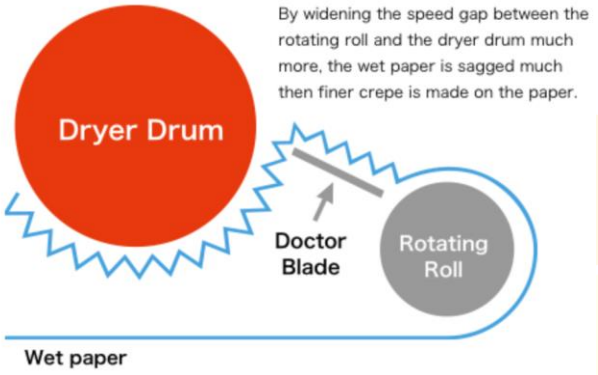
Figure 6. Production method of T-83 filter

Abaca+ filter

Since the water flow within the Abaca paper filter is smooth and steady, the extraction rate can be controlled freely. Although the height of the double-sided crepe in these filters is lower, the very small distance between the crepes results in a larger paper surface area, which facilitates a smoother water flow. Additionally, the uniform texture of the paper allows for easy control of speed and flow, ensuring a consistent flavor in the brewed coffee. This combination of features makes the Abaca+ filter an excellent choice for achieving balanced and flavorful coffee.

Manufacture Process

By increasing the differential in speed between the roller and the drying drum, CAFEC succeeded in making more uniform crepes with the capacity to capture fine particles. As a matter of fact, water flow in this filter is considerably accelerated by increasing the surface area of the paper, not by raising the height of the crepe but by reducing the distance between each crepe. This new design is meant to provide effective filtration while keeping the flow of water smooth and fast, thereby enhancing the whole process of brewing.



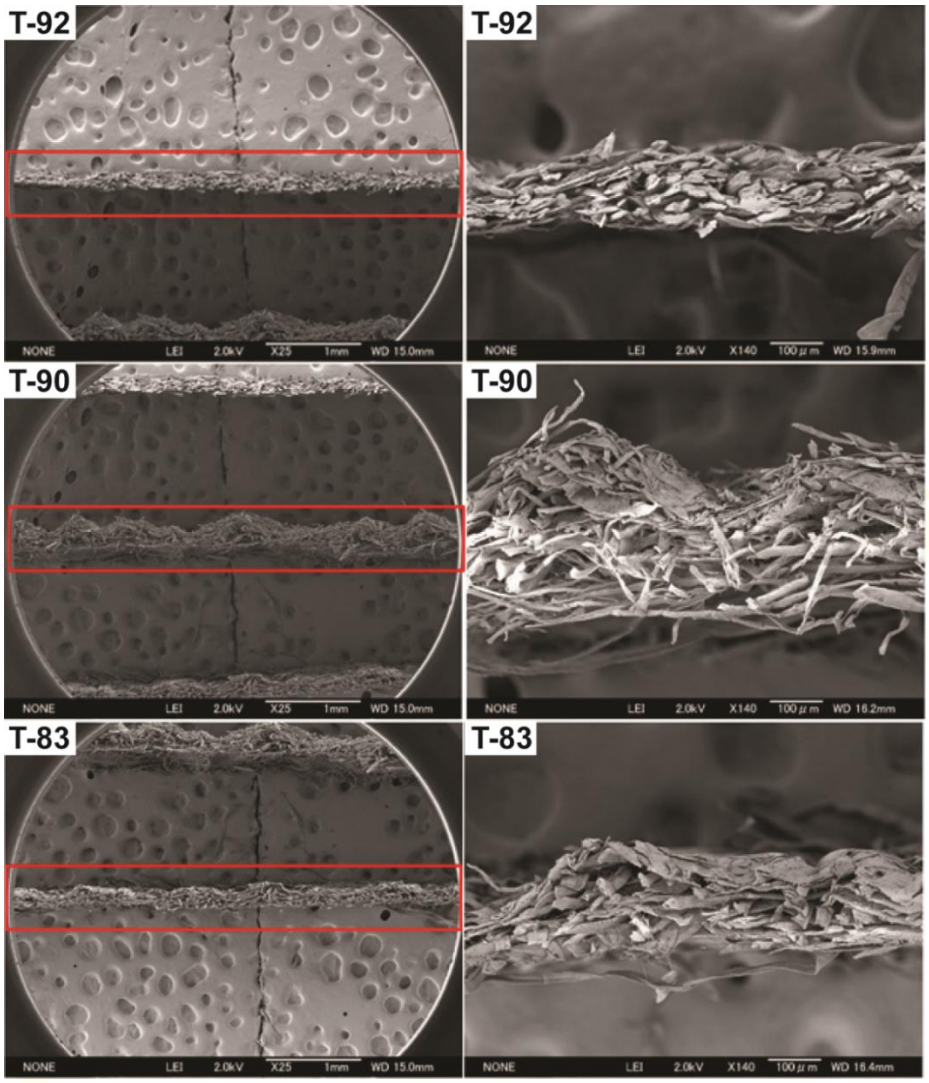


Figure 7. Electron microscopy images of filters T-92, T-90, and T-83

Tools and Equipment:

1. Decent Espresso Machine
2. Radwag Scale (Precision: 0.01)
3. DiFluid Microbalance Scale
4. Jimmy Scale
5. Santoker Roaster
6. Colombian Arabica Green Coffee Beans
7. Specialized Filter Holder (Designed with a 3D printer)
8. Coffee Server Pot
9. Hanna pH Meter
10. DiFluid Refractometer
11. HM Refractometer
12. Beaker
13. Dropper
14. EK43T Mahlkonig Coffee Grinder

Objectives of the Experiment

In the experiment, four models in the CAFEC series of filters were tested: T-92, T-90, T-83, and Abaca+. These tests were designed in view of the claims made by CAFEC company for each filter and in such a way to verify these claims, as will be detailed further in Table 3. Such thorough examination thus enables us to assess the performance and characteristics of each filter in relation to their intended functionality.

1. First Set of Experiments

In these experiments, we tested all four filters using a fixed coffee sample (medium roast with Agtron color number 63 and grind size color number 68, ground to a D50 size of 623 micrometers). This consistency in the coffee used allowed for a fair comparison of the filter performance across all tests. A brewing profile was made using the Decent espresso machine, so there would be no manual interventions or water pouring from the kettle that might introduce errors. This helped in removing manual variables that can cause errors while comparing samples. Furthermore, to segregate the effects of brewing devices from the test results, a specialized tool called a filter holder was fabricated with the help of a 3D printer by the Coffee MIM laboratory team. It is presented in Figure 8 below. Steps for this brewing profile are explained in Table 1.

Table 1. Designed brewing profile for the Decent machine

Step	Time (seconds)	Water Volume (milliliters)	Water Temperature (°C)	Flow Rate (milliliters per second)	Pressure (bar)
1	15	40	90	2	2
2	20	Stop	-	-	-
3	60	133	90	2	2
4	20	Stop	-	-	-
5	110	160	90	2	2

The maximum final volume in the brewing profile was set at 333 milliliters.
The maximum flow rate was established at 2 milliliters per second.
The maximum pressure was maintained at 2 bar.

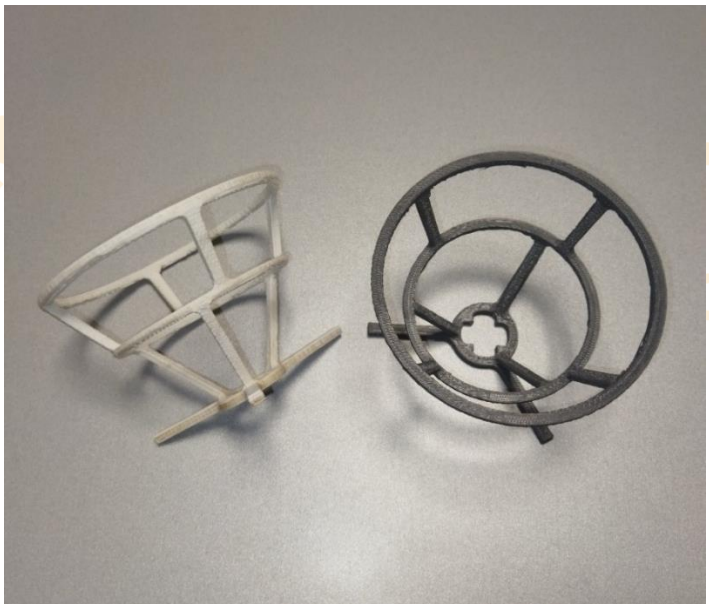


Figure 8. 3D-Printed filter holder designed to eliminate the impact of brewing equipment on test results

Brewing pattern for CAFEC filters set in the Disent Espresso Machine.

Figure 9. Changes in flow rate, bed resistance, pressure, and weight during the brewing profile implementation on the Decent machine

Initially, each filter was placed in the filter holder without any folds, and then rinsed and saturated with 20 grams of hot water at 92 degrees Celsius. After that, 20 grams of ground coffee was added to the filter, and the setup was placed on the scale. The final setup was positioned under the nozzle of Decent machine, and an estimate of brewing time was made by using a stopwatch. The end time for brewing was determined when all the water in the filter had completely drained, the interval between each drip being 10 seconds. Hence, the weight of extraction, filter weight, wet coffee weight, Brix, TDS, % extraction, and pH have been measured for every extraction. Results obtained:

Table 2: Results of testing four filters with medium roast coffee

Filter Name	Abaca+	T-83	T-90	T-92
Coffee Roast Classification	Medium	Medium	Medium	Medium
Coffee Bean Roast Degree (Agtron)	63	63	63	63
Coffee Grind Degree (Agtron)	68	68	68	68
Brewing Time (minutes)	6.13	5.41	5.65	6.52
Dry Coffee Weight (g)	20	20	20	20
Extraction Weight (g)	289.8	291.7	289.9	290.8
TDS%	1.46	1.40	1.45	1.47
Extraction%	21.16	20.42	21.03	21.38
Brix%	1.71	1.64	1.70	1.72
pH	5.00	5.07	5.15	5.14

All results are averages from four repeated trials.
The D50 of the grinds used for testing the filters was 625 micrometers ± 5.

2. Second Set of Experiments

In this series of experiments, we selected a coffee for each of the T-92, T-83, and T-90 filters based on the roast degree claimed by CAFEC. The company's claims regarding these three filters are as follows:

Table 3: CAFEC's claims for each filter regarding suitable coffee and filter impact on flavor

Filter Type	Suitable Coffee According to CAFEC	CAFEC's Claim on Filter Impact	Coffee Bean Roast Degree for Testing	Coffee Grind Degree for Testing
T-92	Light Roast	Aroma and Clean Cup	71.8	92
T-90	Medium Roast	Balance and Flavor	63	68
T-83	Dark Roast	Body and Sweetness	48.5	55.5

The brewing profile designed in the Decent machine for this series of experiments was identical to that of the first group (Table 1). The only distinction in this series was the use of coffee beans with varying roast levels according to CAFEC's claims, where the T-90 filter was tested with medium roast coffee, T-92 with light roast coffee, and T-83 with dark roast coffee. Additionally, the Abaca+ filter was used as a control sample in each of these tests. Each filter was placed in the filter holder without any folds and rinsed with 20 grams of hot water at 92 degrees Celsius. Then, 20 grams of ground coffee were added to the filter and weighed. At last, the final setup was put under the nozzle of the Decent machine and brewing time measured by a stopwatch. The end of the brewing was when all the water dripped from the filter, each drip spaced apart by 10 seconds. Finally, extraction weight, filter and wet coffee weight, Brix, TDS, extraction percentage, and pH were measured for each extraction.

1.2. Results of the T-92 filter test with light roast coffee compared to the Abaca+ filter

Table 4: Results of the T-92 filter test

Filter Name	Abaca+	T-92
Coffee Roast Classification	Light	Light
Coffee Bean Roast Degree (Agtron)	71.8	71.8
Coffee Grounds Roast Degree (Agtron)	92	92
Brewing Time (minutes)	6.13	6.35
Dry Coffee Weight (g)	20	20
Extraction Weight (g)	294.8	292.8
TDS%	1.25	1.28
Extraction%	18.43	18.74
Brix%	1.47	1.50
pH	5.08	5.07

All results are averages from four repeated trials.

The D50 of the grinds used for testing the filters was 625 micrometers ± 5.

2.2. Results of the T-90 filter test with medium roast coffee compared to the Abaca+ filter

Table 5: Results of the T-90 Filter Test

Filter Name	Abaca+	T-90
Coffee Roast Classification	Medium	Medium
Coffee Bean Roast Degree (Agtron)	63	63
Coffee Grounds Roast Degree (Agtron)	68	68
Brewing Time (minutes)	6.13	5.65
Dry Coffee Weight (g)	20	20
Extraction Weight (g)	289.8	289.9
TDS%	1.46	1.45
Extraction%	21.16	21.03
Brix%	1.71	1.70
pH	5.00	5.15

All results are averages from four repeated trials.

The D50 of the grinds used for testing the filters was 625 micrometers ± 5.

2.3. Results of the T-83 filter test with dark roast coffee compared to the Abaca+ filter

Table 6: Results of the T-83 Filter Test

Filter Name	Abaca+	T-83
Coffee Roast Classification	Dark	Dark
Coffee Bean Roast Degree (Agtron)	48.5	48.5
Coffee Grounds Roast Degree (Agtron)	55.5	55.5
Brewing Time (minutes)	5.74	5.39
Dry Coffee Weight (g)	20	20
Extraction Weight (g)	289.2	291.7
TDS%	1.64	1.65
Extraction%	23.71	24.07
Brix%	1.92	1.94
pH	5.51	5.56

All results are averages from four repeated trials.

The D50 of the grinds used for testing the filters was 625 micrometers ± 5.

Figure 10 displays the brew times for each filter with different roast levels of coffee. As previously noted, the T-92 filter required the longest brew time when used with medium roast coffee (6.5 minutes). This prolonged extraction time can be attributed to the high density of the filter (Figure

7) and the resulting blockage of the filter's pores by fine coffee grounds. As for the T-90 filter, our observational records showed that, though its extraction time was not the shortest, the rate at which water flowed out of the end of the filter was very consistent and uniform. The consistency was easily visible to the naked eye and maintained throughout the extraction process of this filtration. Of the rest, the T-83 filter brewed in the shortest time, 5.5 minutes, with a remarkably larger flow rate between its first half and second half of the brewing. In the tests using coffee with the roast levels claimed by CAFEC, the results aligned with these claims, showing no significant discrepancies. In other words, the time differences among the filters, especially compared to the Abaca+ filter, were clearly evident. Thus, we can conclude that all of CAFEC's claims were substantiated.

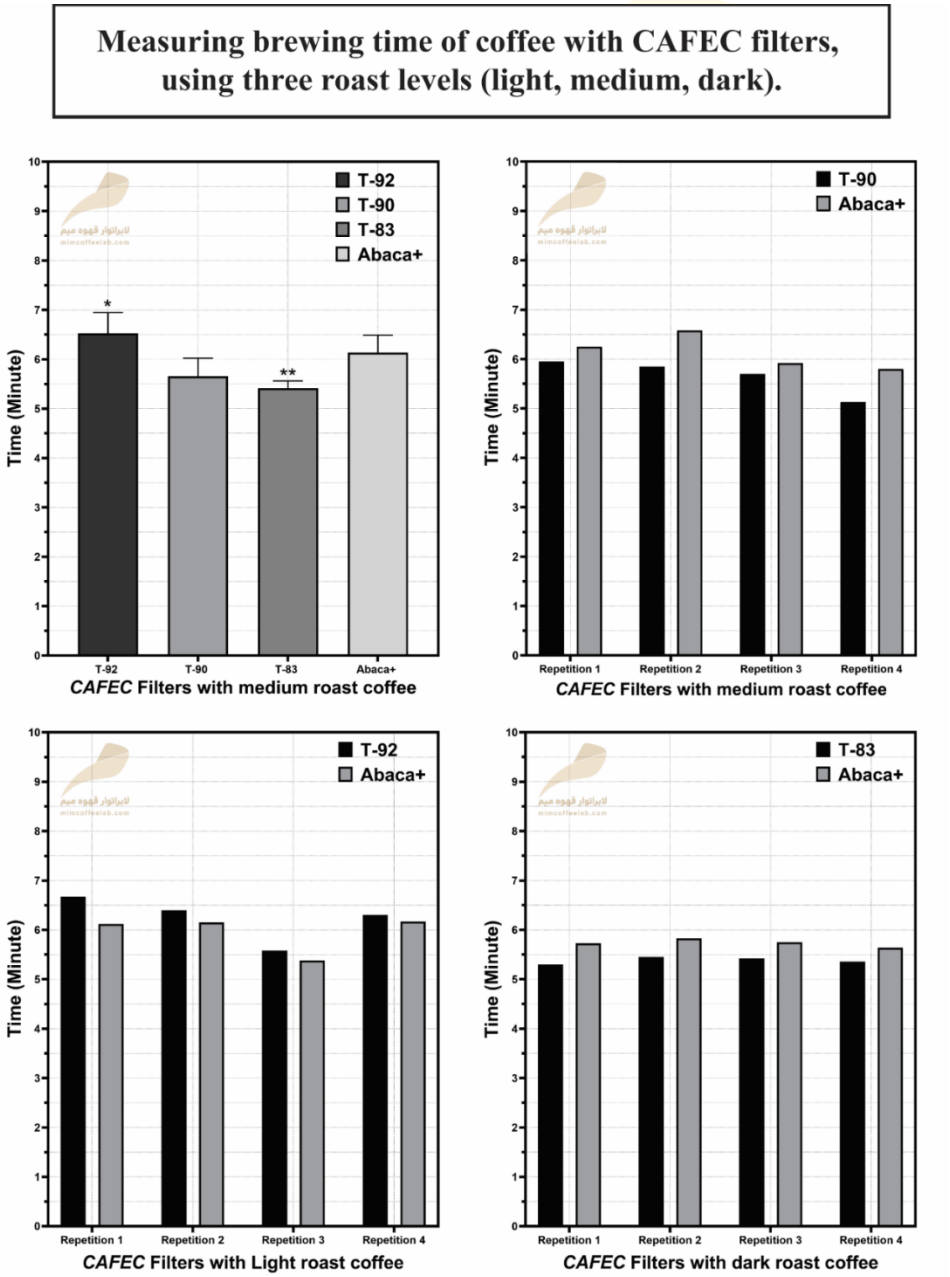


Figure 10. Brew time measurement results with T-92, T-90, T-83, and Abaca+ filters at three roast levels: light, medium, and dark

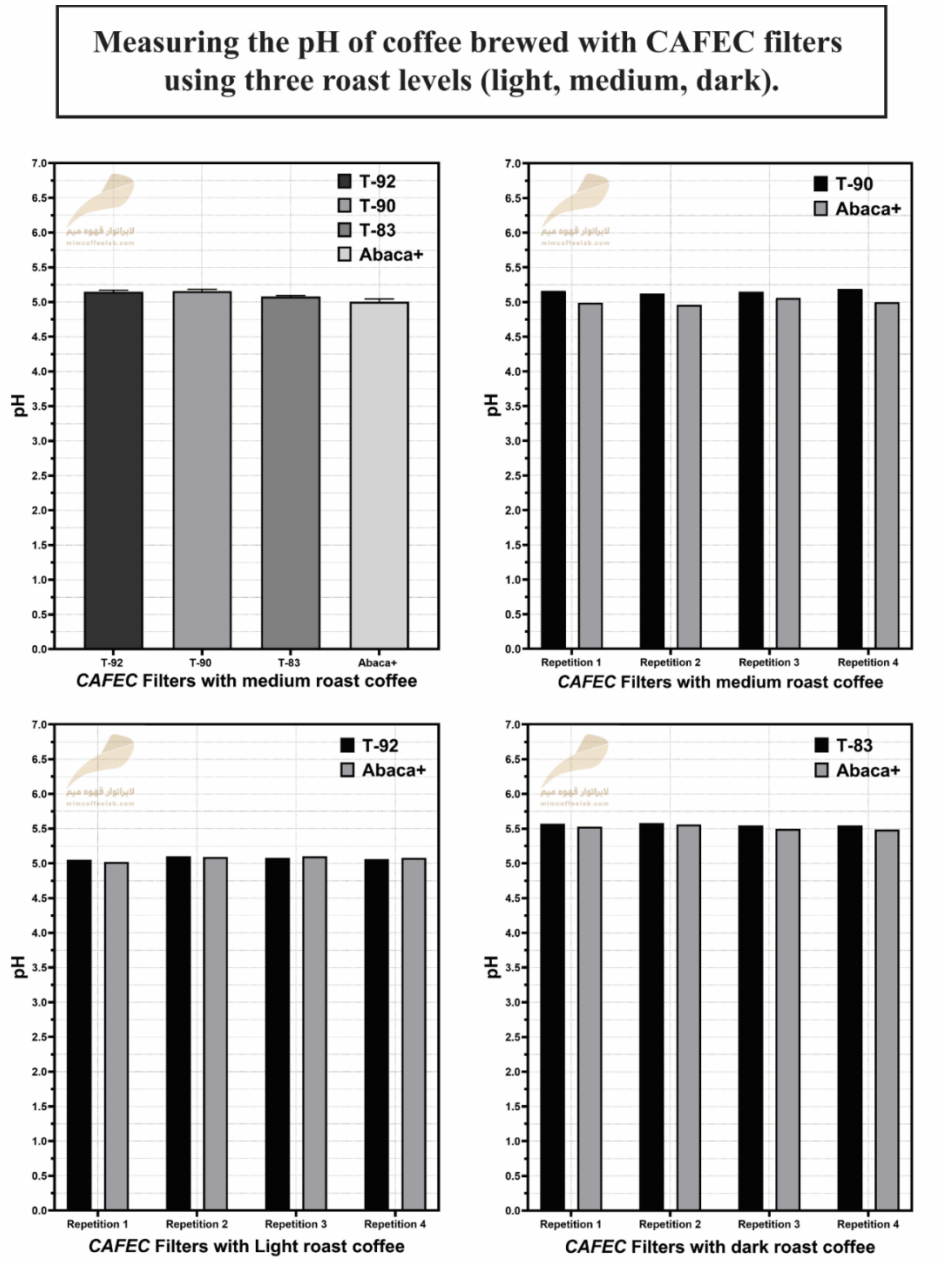


Figure 11. pH measurement results of extracts brewed with T-92, T-90, T-83, and Abaca+ filters at three roast levels: light, medium, and dark roast.

Figure 11 shows the pH as a function of filter type applied. This experiment covers the pH of coffees brewed with various CAFEC filters for three roast levels: light, medium, and dark. The results are presented as follows:

- Medium roast coffee: The T-90, T-83, T-92, and Abaca+ filters showed relatively similar pH levels, indicating a minimal effect of filter type on pH.
- Comparison of T-90 and Abaca+ filters with medium roast coffee: Both filters showed similar pH levels for this roast type.
- Comparison of T-92 and Abaca+ filters with light roast coffee: No significant difference in pH levels was observed for this roast type.

- Comparison of T-83 and Abaca+ filters with dark roast coffee: The type of filter had a negligible impact on pH.

The experiment results show that the filters do not affect the pH of the coffee that much. In fact, at all tested filters with various roast levels, small variations around the measured pH show no meaningful differences among the filters. This would indicate that the filter type has a very minor effect on the characteristics of the coffee acidity, and that the prime influences are probably due more to the chemical properties of the coffee beans themselves and to the methods of extraction rather than to the filter type.

Sensory Analysis Experiments

Based on this, some sensory analysis-based experiments were conducted using different roast levels of coffee across all four filters. The sections after this will introduce these three experiments and their results on the sensory attributes of the coffees made from the light, medium, and dark roasts; a comparison for flavor, body, sweetness, acidity, aftertaste, and aroma across different filters. Each experiment will be related to only one roast level, and it will show the performance of different filters.

1. Experiment with Medium Roast Coffee

Figure 12 compares the sensory attributes of three CAFEC filters for the brewing of medium roast coffee. As can be seen, the T-92 filter registered the highest scores for flavor, aroma, and more especially, acidity. The increase in aroma from coffee brewed with this filter was easily detectable and fulfilled the claim by CAFEC of its capability to give aroma and a clean cup.

The aftertaste and body were best in T-90 filter with the medium roast. It was also found to be the most suitable filter for brewing at this roast, since it imparted a better balance to the flavor.

Regarding sweetness, the score was highest for the T-83 filter; hence, CAFEC's statement that it enhances the sweetness in the brew is hereby substantiated.

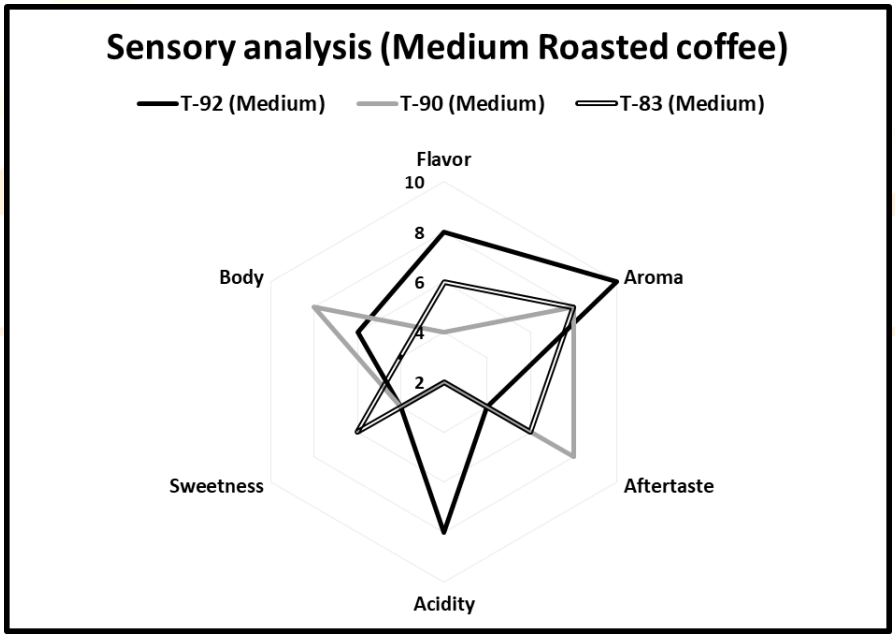


Figure 12: Sensory analysis results of the brewed extracts from the T-92, T-90, and T-83 filters using medium roast coffee

2. Experiment with Light Roast Coffee

The recommended coffee for the T-92 filter is light roast, so this roast level was used to test this filter (Figure 13). In this test, the Abaca+ filter was used as a control sample. As shown in the chart, the T-92 filter also scored high in aroma and flavor characteristics at the light roast level.

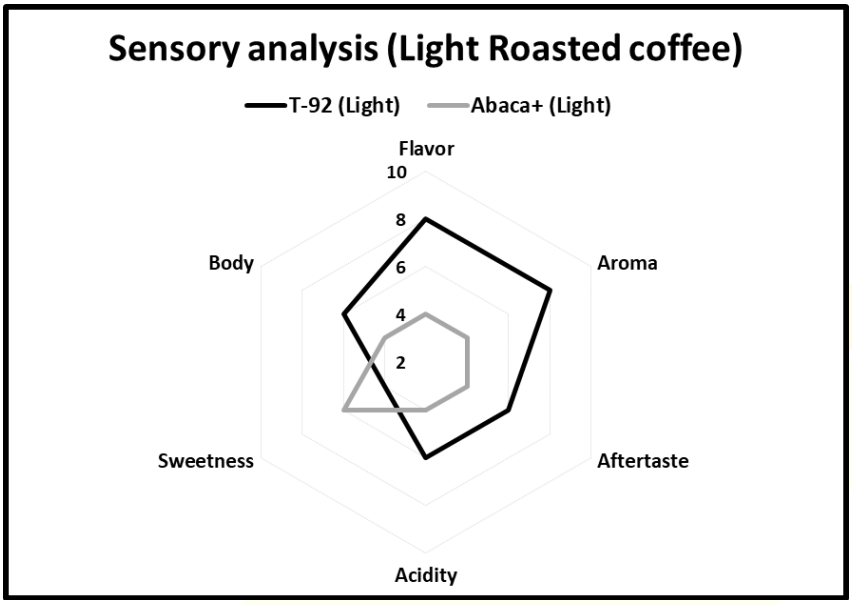


Figure 13. Sensory analysis results of the brewed extracts from the T-92 and Abaca+ filters using light roast coffee.

3. Experiment with Dark Roast Coffee

In this chart, the T-83 filter was evaluated with dark roast coffee in the presence of the Abaca+ filter as a control (Figure 14). As shown in the chart, the extract obtained from the T-83 filter exhibited a high body, which supports the claims made by CAFEC. It is worth noting that at the dark roast level, the sweetness characteristic is not very pronounced.

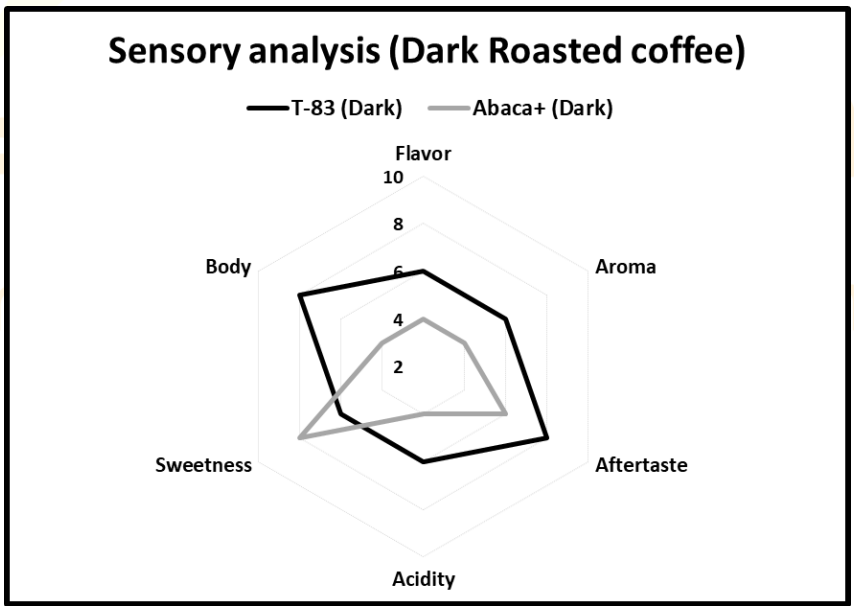


Figure 14. Sensory analysis results of the brewed extracts from the T-83 and Abaca+ filters using dark roast coffee.

Overall, results from this section indicate that full exploitation of all four filters is required for baristas and coffee enthusiasts. Due to a lack of complete knowledge related to the characteristics of each filter, most coffee lovers use only the general Abaca+ for brewing their coffee. In contrast, using the three specialized CAFEC filters allows the possibility of offering various aromas and flavors in the final cup. The brewing results using the T-90 filter demonstrated that this could be an all-around filter if the flavor is balanced. When brewing a specific roast, it can be tested with all three specialized filters to ultimately choose which would be the best on it based on what sensory characteristics are best in that roast. Conclusion The results of this study show that using different filters has a direct impact on the sensory attributes of coffees with differing roast levels.

Experiments of Total Dissolved Solids

In Figures 15 and 16, you can see the control charts for brewed coffee, which compare the performance of different CAFEC filters at various roast levels.

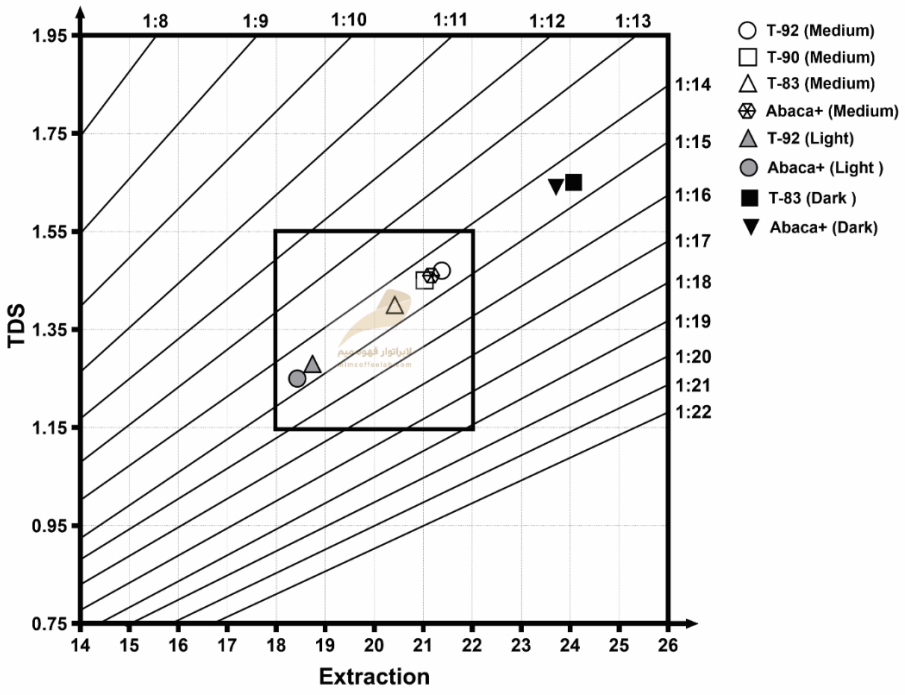


Figure 15. The positioning of brewed coffees using the T-92, T-90, T-83, and Abaca+ filters at three roast levels: light, medium, and dark, in the control chart for brewed coffee.

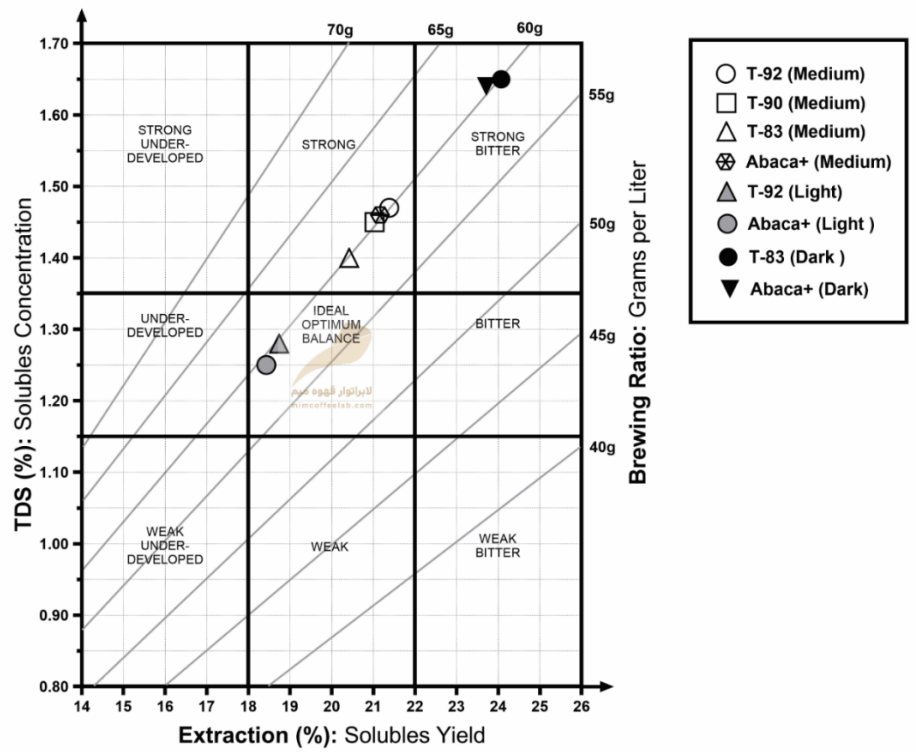


Figure 16. The positioning of brewed coffees using the T-92, T-90, T-83, and Abaca+ filters at three roast levels: light, medium, and dark, in the classic control chart for brewed coffee.

The brewed coffee control chart will allow for a more sensitive investigation and analysis of brewed coffee. Near-ideal flavors can be achieved with careful adjustment of brewing times and the use of suitable filters. The chart now becomes a powerful teaching tool in understanding the brewing process. In the classic chart for brewed coffee, the ideal zone is generally up to TDS 1.35%, although other charts extend this to 1.45% and even 1.55%.

Regarding dark-roasted coffees, higher solubility due to the breakdown of cell walls and increased fine particles leads to over-extraction, which is expected. For light-roasted coffees, the low solubility can be offset by using the T-92 filter, which creates a slower flow (trapping fine particles) and brings the extraction into the ideal range. This characteristic allows for light roast extraction to reach the higher end of the ideal range when replaced with medium roast coffee.

Medium-roasting enables us to adjust the extraction throughout the ideal range with different filters since, at that roast degree, the solubility is suitable. The brewing of coffee will be highly influenced by several factors, such as filter type and roast degree. Based on the results, light roast is not an appropriate choice for brewed and filtered extraction. This finding also holds true for dark roast. Certainly, using coffee with a medium to light roast can yield better brewed extracts.

An important observation regarding medium-roast coffee extracted with the T-83 filter is that while the extractions from the other three filters are positioned at the highest point of the ideal range, the T-83 extraction sits in the middle of the chart.That would be because, with the T-83 filter, the product flows more swiftly and is extracted smoother, hence reducing extraction time against the other three filters.

Another important consideration would be that despite the very similar proximity of the T-90, T-92, and Abaca+ filters on the graph, they all have basic sensory differences, as will be shown in

the section on sensory evaluation. The results of the pH and refractometry tests show that the differences between these are not based on traditional chemical variations but probably come from an important role played by fine particles that modify the speed of extraction. The speed can cause modifications of the end extract in a molecular way and create the above-mentioned sensory characteristics.

Recommendations and Conclusion

- Occasionally, we encounter coffees with the same roast level but differing depths of roast, which can significantly affect solubility and the production of fines. Having different filters can greatly optimize the final extraction, so it's important not to rely solely on labels like light, medium, or dark roast.
- We have a range of Agtron degrees for each level of roast classification: light, medium, and dark. For example, medium roast is considered to be between 55 and 65 Agtron. Between 45 and 55 Agtron is termed medium to dark, while degrees below 45 Agtron are classified as dark. The 2023 beta version of the sensory evaluation reference classifies a bitterness standard as coffee with a roast level of 35 Agtron. All these points highlight the necessity of color measurement in creating an ideal cup of coffee.
- Using coffee with a light to medium roast can yield significantly better results (65 to 75 Agtron), as the extraction level at medium roast will often exceed the desirable range for brewing unless adjustments are made to grind size to increase the fines factor.
- Regarding grind size, parameters such as the type of grinder and filter have a significant impact. Fines with a high volume slow down the extraction rate and increase the extraction percentage of soluble compounds. Additionally, using filters with high density, such as T-92, which have lower extraction speeds (due to fines being trapped in the pores and reducing water flow), will yield similar results.
- Employing techniques to remove fines through sieving could produce dramatic changes in the final extraction, with great modification in filter behaviour. This method could eliminate the limitation imposed by coffees with a high amount of fines, which slow the water flow through the filter.
- The T-90 filter is highly recommended for those seeking more repeatability in extraction, especially at cafes. This ensures consistency in flow rate and repeatability compared to other filters.
- T-83 and T-92 filters are recommended for enthusiasts of brewing tools where there is considerable airflow around the filter, such as with Origami. It behaves differently compared to regular brewing equipment.
- Ultimately, with consideration of your expectation about the final characteristics of the coffee beans, you can select an appropriate filter according to your needs based on the proven claims by CAFEC in the Coffee MIM laboratory and enjoy your professional brewing cup.